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"different paths, one vision"
«chemins divers, visée commune»

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ABSTRACTS
RÉSUMÉS

Colloque : Le développement des relations du Canada avec l'Asie-Pacifique

Claude Yves Charron

Évolution des échanges académiques entre le Canada et le Bassin du Pacifique : enjeux, contraintes et perspectives de développement

Cet essai discute des enjeux, contraintes et perspectives de développement de nos échanges académiques avec la région en fonction d'une problématique se distribuant à trois niveaux :
a) au niveau micro, les mouvements d'inscriptions d'étudiants de la région au sein de nos institutions et le concept de «juste équilibre»;
b) au niveau inter-institutionnel, les différents programmes d'échange, ainsi que les problèmes de capacité d'absorption;
c) et enfin au niveau macro, la nouvelle stratégie dite «Pacifique 2000» et le rôle de médiateur que devrait y assumer, en termes de concertation, la Fondation Asie-Pacifique du Canada.

Evolution of the Academic Exchanges Between Canada and the Pacific Rim: Issues, Constraints and Development Perspectives

This essay considers different types of issues, constraints and development perspectives of our academic exchanges with the region on three different levels:
a) at the micro level, the flow of students from the region within our institutions and the concept of "right mix";
b) at the organizational level, the different exchange programs and the problems related to their absorptive capacity;
c) and finally, at the macro level, the new Pacific 2,000 Strategy, and the role of mediator, in terms of dialogue, which the Asia Pacific Foundation should assume.

Jacques Lamontagne
L'enseignement supérieur en Chine : développements récents

Le présent exposé fait ressortir les principales caractéristiques de l'évolution de l'enseignement supérieur en Chine au cours des années 80. Il insiste notamment sur la réforme pédagogique, les institutions de haut savoir et les échanges internationaux. Il convient de distinguer les facteurs qui peuvent avoir contribué à réduire ou à accentuer les disparités pédagogiques existant entre les régions d'une part et les groupes sociaux d'autre part.

L'évolution que connaît depuis peu l'enseignement supérieur en Chine se caractérise par la décentralisation de plusieurs fonctions administratives et la diversification des formes de l'enseignement supérieur. À noter particulièrement la prolifération des universités professionnelles de cycle court et la montée en flèche des cours universitaires télévisés. Ces phénomènes pourraient bien renforcer les différences socio-économiques et régionales. Néanmoins, les changements réalisés ont pour objet de tirer le meilleur parti des ressources disponibles en les adaptant aux conditions socio-économiques inhérentes à chaque région. Les institutions de haut savoir seront encore fonction d'un ordre hiérarchique, mais les nouvelles structures, quoique moins prestigieuses, s'adapteront mieux aux besoins en main-d'œuvre spécialisée. On estime que cette orientation, très fortement marquée, prendra encore plus d'ampleur dans le courant des années 90.

Higher Education in China: Recent Developments
This presentation outlines the main characteristics of the development of higher education in China during the eighties, centering on educational reform, institutions of higher education, and international exchanges. Of particular note are the factors that may have contributed to the decrease or the increase of educational disparities between regions and between social groups.

The recent developments of higher education in China are characterized by the decentralization of several administration functions and the diversification of the forms of higher education. Especially noteworthy are the proliferation of short-term professional universities and the accelerated development of university on television. These phenomena could reinforce regional and socio-economic differences. But the purpose of the changes implemented is to optimize the available resources by adapting them to the socio-economic conditions specific to each region. There will still be a hierarchy of institutions of higher education. However, the new forms, although less prestigious, are more adaptable to the needs of specialized manpower. It is expected that this strong movement will continue to gather momentum well into the nineties.

Claude Comtois, François Soulard et Jean-Paul Rodrigue
L'avant-pays canadien des ports chinois

La notion d'avant-pays est multidimensionnelle, beaucoup plus que celle d'arrière-pays. L'avant-pays est à la fois un espace maritime et terrestre. La

notion d'avant-pays se modifie avec la spécialisation commerciale, les types de produits, et la fréquence de contact. L'objectif est de présenter une nouvelle méthodologie pour agréger les configurations spatiales du transport maritime à l'échelle mondiale à partir d'informations à micro-échelle sur le flux de biens maritimes. La méthodologie sera appliquée pour évaluer les impacts des mutations du commerce international sur les activités portuaires chinoises à la lumière de quelques propositions clés : 1) les conditions du trafic contemporain ont nombre de conséquences sur le développement des infrastructures portuaires; 2) les politiques chinoises de développement portuaire ne doivent pas seulement se concentrer sur des facteurs internes mais aussi sur quelques facteurs externes, tels que les politiques régionales et les stratégies de développement des infrastructures de transport des pays partenaires commerciaux; 3) les conteneurs offrent un avant-pays plus continu, en étendant la zone d'influence des principaux ports d'une façon plus importante que ne le permet le transport des marchandises en vrac dont le parcours est plus simple. Cette communication cherchera à examiner l'avant-pays canadien des ports chinois. Nous analyserons d'abord comment les facteurs de localisation affectent les modèles d'interaction, ce qui résultera en une présentation méthodologique. Les aspects contemporains des ports chinois et canadiens seront ensuite examinés. Ceci sera suivi d'une analyse de l'impact sur le transport maritime de l'entrée de la Chine au marché économique mondial. Nous évaluerons ensuite le commerce maritime sino-canadien. Nous conclurons par une analyse des implications possibles sur les politiques d'investissement, notamment dans le secteur des transports maritimes.

The Canadian Foreland of Chinese Harbours

The concept of foreland is multidimensional, much more than that of backland. The foreland area belongs to the sea as well as the land. The concept changes with commercial specialization, types of products and frequency of contact. The aim is to present a new methodology for aggregating the spatial patterns of maritime transport on a global scale based on micro-scale data about the flow of maritime goods. That methodology will be used to evaluate the impact of mutations in the nature of international trade on activities in Chinese harbours given the following key propositions: 1) the characteristics of modern traffic have various consequences in terms of the development of harbour equipment; 2) Chinese policies on the development of harbours must not only concentrate on internal factors but also on some external ones, such as regional policies as well as the strategies that trading partners follow for the development of their own transport infrastructure; 3) containers make for a more continuous foreland by extending the area of influence of the main harbours on a much larger scale than bulk transport, which follows simpler routes. The aim of this article is to analyze the Canadian foreland of Chinese harbours. Localization factors affecting interaction models will be studied first, to arrive at a methodological structure. The present characteristics of Chinese and Canadian harbours will then be looked into. An analysis of the impact on maritime transport of China's arrival on the world market will follow, before

maritime trade between Canada and China is taken into consideration. The article concludes with an analysis of potential effects on investment policies, by the maritime transport sector in particular.

Symposium: Canada and the Growing Presence of Asia

Ardo H. Hansson and John F. Helliwell, F.R.S.C.
The Evolution of Income and Competitiveness in the North Pacific Rim

Things tend to be more expensive in the richer countries, and growth is faster in Asia than in North America. This paper digs deeper into these everyday beliefs and assesses the extent to which they are linked together. An explanation is proposed which first links the theory of economic convergence with the view that a country's price level depends positively on its per capita real income, and then links these price levels to competitiveness. Tests of this model, and the data required for these, are described. When applied to figures for the North Pacific Rim, the results are broadly supportive of the proposed model. Implications for the likely evolution of income and competitiveness in this region are described.

L'évolution des revenus et de la compétitivité dans le bassin du Pacifique nord
Les choses ont tendance à être plus coûteuses dans les pays riches et la croissance à être plus rapide en Asie qu'en Amérique du Nord. Ce document examine davantage ces opinions répandues et évalue dans quelle mesure ces deux aspects sont liés. On propose une explication qui rattache tout d'abord la théorie de la convergence économique à l'idée que le niveau des prix dans un pays donné dépend positivement de son revenu réel par habitant puis lie ces niveaux de prix à la compétitivité. On décrit les essais effectués dans le cadre de ce modèle ainsi que les données nécessaires. Lorsqu'ils sont mis en rapport avec les chiffres correspondant au Bassin du Pacifique nord, les résultats étayent dans les grandes lignes le modèle proposé. Les conséquences de ce fait sont décrites du point de vue de l'évolution probable des revenus et de la compétitivité dans cette région.

Michael A. Goldberg
Vancouver: A Pacific Rim City in the Making and the Hong Kong Connections that are Helping to Shape its Pacific Future

Vancouver has captured the broad media attention recently. The issue all this attention raises, and the one addressed here is, "Why has this former milltown been the centre of so much media interest?" It is argued that Vancouver is a metaphor not just for the way North America is being drawn closer to the Asia Pacific Region, but as a metaphor for the dawning Pacific Rim reality where the ocean no longer acts as a barrier to movement and economic integration. Rather the Pacific serves as both symbol and vehicle to unify the nations and economies on its eastern and western shores.

Vancouver represents a prototype for this new era of trans-Pacific integration and linkage. Thus, Vancouver as prototype and as metaphor is the main focus of this discussion, where we see cities as no longer purely local creatures but rather as parts of the global economy. An assessment such as that done here, of how Vancouver is affected by and has reacted to these global, especially Pacific, pressures, therefore is instructive and of significant potential use to others for whom the Vancouver prototype is or may be relevant now or in the future.

Vancouver : La création d'une ville du Bassin du Pacifique et son avenir modelé par les liens avec Hong-Kong

Vancouver a récemment reçu beaucoup d'attention de la part des médias. Cela amène à se demander, ce dont on traite ici, «pourquoi ce qui n'était auparavant qu'une ville de scieries suscite-t-elle tant d'intérêt chez les médias?» On avance que Vancouver symbolise non seulement la façon dont l'Amérique du Nord se rapproche de la région Asie-Pacifique mais aussi le fait que, dans la nouvelle réalité du Bassin du Pacifique, l'océan a cessé de faire obstacle aux déplacements et à l'intégration économique. Le Pacifique est maintenant à la fois le symbole et le véhicule qui unit les nations et les économies de ses rives occidentales et orientales.

Vancouver constitue un prototype de cette nouvelle ère d'intégration et de liens trans-Pacifique. Le cas de Vancouver est donc placé ici au centre de cette analyse où l'on ne perçoit plus simplement les villes comme des créations purement locales mais plutôt comme des éléments de l'économie planétaire. Le genre d'évaluation qui est faite ici de la façon dont Vancouver est affectée par ces pressions émanant de l'ensemble de la planète, et plus particulièrement du Pacifique, et dont elle y réagit, est donc instructif et pourrait être utile pour d'autres personnes pour qui le prototype que constitue Vancouver est pertinent ou pourrait le devenir.

Symposium: Marine Resources of the North Pacific

Tanya Atwater
Tectonics of the Northeast Pacific

Much of the tectonic activity and history of the northeast Pacific can be understood in terms of plate tectonic interactions. Spreading centres in the region show a broad range of rate-dependent characteristics and are especially noted for their hydrothermal vents, ore deposits and related exotic animal colonies. The San Andreas and Queen Charlotte-Fairweather continental transform faults are important for their earthquake potential, particularly in the Los Angeles area where a great earthquake seems imminent. Subduction zones in Alaska and Cascadia are marked by major explosive volcanic events. Subduction is also responsible for very large earthquakes in the Alaskan-Aleutian region, and ground deformations suggest that the Cascadia region may also be subject to such catastrophies.

The tectonic history of the region can be discerned from magnetic isochrons recorded in the seafloor of the northeast Pacific and from the geologic record in the rim of North America. These demonstrate the former existence of several large oceanic plates that have since been subducted. This resulted in a long-term, variable history of subduction, followed by a gradual transition to the present, transform-dominated configuration. Of particular interest are the numerous terranes that travelled in various ways along or across the Pacific to be accreted to North America. These now make up most of Alaska and a major portion of the rest of the Pacific rim.

La tectonique du nord-est du Pacifique
Une bonne partie de l'activité tectonique actuelle et passée du nord-est du Pacifique peut être comprise en termes d'interaction entre plaques tectoniques. Les centres de propagation de la région présentent une vaste gamme de caractéristiques liées aux mouvements des plaques et en particulier des évents hydrothermiques, des gisements de minerai et des colonies connexes de faune exotique. Les failles transversales continentales de San Andreas et de Queen Charlotte-Fairweather sont importantes du point de vue du potentiel séismique qu'elles révèlent, surtout dans la région de Los Angeles où un tremblement de terre de forte intensité semble imminent. Les zones du subduction d'Alaska et des Cascades se caractérisent par des explosions volcaniques majeures. La subduction est aussi à l'origine de très forts tremblements de terre dans la région de l'Alaska et des Aléoutiennes et certaines déformations du terrain donnent à penser que la région des Cascades pourrait elle aussi connaître de telles catastrophes.

On peut discerner l'histoire tectonique de la région dans les courbes isochrones magnétiques enregistrées au fond de la mer dans le nord-est du Pacifique et grâce aux caractéristiques géologiques de la lisière de l'Amérique du Nord. On a ainsi pu démontrer qu'il existait autrefois plusieurs grandes plaques océaniques qui ont depuis disparu par subduction. Cette région a donc connu une longue période de subduction marquée par des fluctuations, suivie par un passage graduel aux conditions actuelles où les décrochements dominent. Les nombreuses formations géologiques qui se sont déplacées de diverses façons le long du Pacifique ou à travers celui-ci pour venir former une accrétion en Amérique du Nord présentent un intérêt particulier. Ces formations constituent en effet maintenant l'essentiel de l'Alaska et la majeure partie du reste du pourtour du Pacifique.

Richard Hebda and S. Gay Frederick
History of Marine Resources of the Northeast Pacific Since the Last Glaciation

Data from fossil deposits, archaeological deposits, ethnographic records and modern analogs are used to reconstruct the history of marine faunal resources in the northeast Pacific during the last 14,000 years. From 14,000 to 10,000 years ago, glaciers melted, relative sea levels fluctuated dramatically, and an

unstable nearshore environment characterized by cool, sediment-laden water of varying salinity, supported molluscan species similar to those in the area today. Little is known of offshore environments or non-molluscan resources. Between 10,000 and 5,000 years ago, the nearshore environment stabilized although sea levels continued to fluctuate. Nearshore waters were slightly warmer than today and the open ocean environment was much like the present one. Extant salmon, inshore fish, mollusc, sea mammal and sea bird species were present and widely used by the inhabitants along the coast, especially after 6,000 years ago. Since 5,000 years ago marine resources, especially clams, have been intensively used. These marine resources supported hundreds of thousands of people and served as the base for complex coastal cultures. Regional differences developed with outer coast peoples depending more on sea mammals and marine fish whereas inshore delta peoples relied more on salmon. With the coming of Europeans 200 years ago, over-harvesting and severe depletion of specific marine resources such as whales, sea otters, fur seals and some marine fish, began.

L'histoire des ressources marines du nord-est du Pacifique depuis la dernière glaciation

Les données extraites des gisements de fossiles et de gisements archéologiques, les archives ethnographiques et leurs analogues modernes permettent de reconstituer l'histoire de la faune marine du nord-est du Pacifique durant les derniers 14 000 ans. À une époque qui se situe à quelque 14 000 à 10 000 ans dans le passé, les glaciers ont fondu, les niveaux relatifs de la mer ont connu des fluctuations prononcées et un milieu côtier instable caractérisé par des eaux froides chargées de sédiments et de salinité variable abritait des espèces de mollusques ressemblant à celles que l'on trouve aujourd'hui dans ces régions. Notre connaissance sur les milieux du large ou les ressources en espèces autres que les mollusques est limitée. Entre 10 000 et 5 000 ans avant notre époque, le milieu côtier s'est stabilisé même si les niveaux de la mer ont continué de fluctuer. Les eaux littorales étaient légèrement plus chaudes qu'aujourd'hui mais la haute mer ressemblait beaucoup à ce qu'elle est maintenant. Les espèces actuelles de saumon, de poissons côtiers, de mollusques, de mammifères marins et d'oiseaux de mer existaient déjà et étaient largement exploitées par les habitants de la côte, surtout dans les 6 000 dernières années. Depuis 5 000 ans, les ressources marines, et surtout les myes, ont été intensivement exploitées. Ces ressources faisaient vivre des centaines de milliers de gens et servaient de base à de complexes cultures littorales. Des différences régionales ont vu le jour entre les peuplades côtières, qui dépendaient davantage des mammifères marins et des poissons de mer, et les populations de l'intérieur des deltas qui comptaient surtout sur le saumon. Avec l'arrivée des Européens, voilà 200 ans, a commencé une surexploitation et un grave épuisement de certaines ressources marines comme les baleines, les loutres de mer, les phoques et certains poissons de mer.

Paul H. LeBlond, F.R.S.C. and Keith A. Thomson
The North Pacific Ocean Environment

We describe the broad oceanographic features of the North Pacific ocean, showing that it may be considered as a two-layer system. The upper layer is driven by the atmosphere, cooled and warmed seasonally and blown along by the wind in two large-scale circulation cells: the counterclockwise sub-polar gyre and the clockwise sub-tropical gyre. The lower layer, below 150 m, is beyond local atmospheric influence over most of the Pacific and partakes in a world-wide thermohaline circulation, driven by the sinking of cold, salty waters in the North Atlantic and in the Antarctic regions. Consideration of the great spatial and temporal variability of ocean properties revealed by modern techniques such as satellite photography leads to the conclusion that ocean currents are as variable as the winds and that present knowledge of ocean properties is inadequate to fully understand the ocean's role in climate change, its effect on fish migration, growth and survival at sea, or its ability to disperse pollutants.

L'environnement du Pacifique nord
Nous décrivons les principales caractéristiques océanographiques du Pacifique nord en montrant qu'on peut le considérer comme un système à deux couches. La couche supérieure, qui est influencée par l'atmosphère, se refroidit et se réchauffe de façon saisonnière et est poussée par les vents dans deux cellules de circulation à grande échelle : le courant giratoire sub polaire, qui tourne dans le sens inverse des aiguilles d'une montre, et le courant giratoire sub tropical, qui tourne dans le sens des aiguilles d'une montre. La couche inférieure, en dessous de 150 mètres, échappe aux influences atmosphériques localisées dans la majeure partie du Pacifique et participe à la circulation thermohaline mondiale, poussée par l'enfoncement des eaux froides et salées dans l'Atlantique nord et dans les régions antarctiques. L'étude de la grande variabilité spatiale et temporelle des propriétés océaniques qu'ont permise des techniques modernes comme la photographie par satellite a mené à conclure que les courants océaniques sont aussi variables que les vents et que l'état actuel des connaissances des propriétés de l'océan ne suffit pas à pleinement comprendre le rôle que joue l'océan dans l'évolution du climat, son effet sur les migrations et sur la croissance et la survie des poissons en mer ou sa capacité à disperser les produits polluants.

Peter A. Larkin, F.R.S.C.
Fisheries Resources of the North Pacific Ocean

Fisheries resources comprise those species of marine organisms that are harvested by man. The Asian coast of the North Pacific is highly productive biologically and has a long tradition of fishing. The North American coast is less productive and fishing has been concentrated on a few species.

Pacific Salmon feed across the full expanse of the North Pacific returning to their streams of origin. Total catch of the five commercially important species peaked in the decade 1927-36; they declined thereafter as a consequence of excessive fishing. Since 1974 when 200-mile limits went into effect, stocks have recovered, because of more prudent management and enhancement measures. Other species of significance in the mid-ocean reaches are pomfret, lantern fish, fur seals and whales.

Fisheries of the Asian coast are concentrated on pelagic species such as herring, anchovies, sardines, saury, squid and mackerel which show large fluctuations in abundance. Demersal species such as cod and flatfish have sustained relatively small fisheries. As demand increased, fleets moved north and east to fish the Sea of Okhotsk and the Russian coast for demersal species, particularly, haddock.

In the 1950s and 1960s Japanese and Soviet fishing operations expanded rapidly into the Eastern Bering Sea. After 200-mile limits were imposed, management came largely under the control of the United States. Stocks are now fished at maximum levels of sustainable yield.

North American fisheries concentrated on salmon, herring, sardines, halibut and in recent decades, various demersal species. There are substantial potentials for fisheries for anchovies, hake and jack mackerel.

North Pacific fisheries are not as fully exploited as those of other regions but are approaching or exceeding their limits, especially on the Asian side. World catch is now 100 million tonnes, of which aquaculture is about 15 million and rising. Global climatic change may have impacts on ocean circulation and is a major imponderable for the future.

Les ressources halieutiques de l'océan Pacifique nord

Les ressources halieutiques sont constituées de toutes les espèces marines que l'homme exploite. La côte asiatique du Pacifique nord est biologiquement très productive et la pêche y est une tradition très ancienne alors que sur la côte nord-américaine, moins productive, elle se concentre sur quelques espèces.

Le saumon du Pacifique se nourrit à la grandeur du Pacifique nord sur son trajet de retour vers son ruisseau d'origine. Le total des prises des cinq espèces commercialement importantes a culminé entre 1927 et 1936 pour décliner par la suite du fait d'une pêche excessive. Depuis 1974, année où l'on a institué la limite des 200 milles, les stocks se sont rétablis grâce à une gestion plus prudente et à des mesures d'amélioration. Les autres espèces importantes pour la pêche mi-hauturière sont la castagnole, le poisson-lanterne, les phoques et les baleines.

Les pêches de la côte asiatique exploitent principalement des espèces pélagiques comme le hareng, les anchois, les sardines, le balaou, le calmar et le maquereau dont l'abondance fluctue considérablement. Les espèces démersales comme la morue et le poisson plat soutiennent des pêches relativement restreintes. À mesure que la demande s'est accrue, les flottes de pêches se sont déplacées davantage vers le nord et vers l'est pour aller chercher le

poisson dans la mer d'Okhotsk et sur la côte russe pour les espèces démersales, en particulier l'aiglefin.

Dans les années 50 et 60, les flottes de pêche japonaises et soviétiques ont rapidement pris de l'expansion dans la partie orientale de la mer de Béring. Lorsque la limite des 200 milles a été imposée, la gestion de ces stocks est pour l'essentiel passée sous la responsabilité des États-Unis. Les stocks sont maintenant exploités aux niveaux maximums permettant un rendement durable.

Les pêches nord-américaines se sont concentrées sur le saumon, le hareng, les sardines, le flétan et, au cours des dernières décennies, sur diverses espèces démersales. Il existe un potentiel notable de pêche à l'anchois, au merlu et au chinchard.

Les pêcheries du Pacifique nord ne sont pas exploitées aussi intensément que celles des autres régions mais elles approchent de leurs limites et les ont même parfois dépassées, surtout du côté asiatique. Les prises mondiales se situent maintenant à 100 millions de tonnes sur lesquelles l'aquaculture fournit environ 15 millions de tonnes, une proportion qui va en s'accroissant. L'évolution du climat mondial pourrait avoir une incidence sur la circulation océanique et constitue l'un des grands éléments d'incertitude pour l'avenir.

John E. Bardach
Aquaculture and Food: Opportunities and Constraints

Aquaculture, the farming and tending of animals and plants in fresh and sea water, has grown faster than fisheries in the last three decades. Fish stocks are heavily exploited, world-wide, and locally depleted. Aquaculture is therefore expected to supply increasing portions of animal protein of aquatic provenance, particularly in nations that have fish as substantial parts of their diet. The introduction of animal breeding techniques and certain measures of biotechnology into the culture of aquatic animals, advances in the artificial feeding of carnivorous fish and of crustaceans, disease control of these same organisms, and greater application of engineering in the techniques of rearing the cultivars will favour aquaculture development world-wide, but most prominently in the tropics where such culture still has many traits of simpler craft. Competition for and pollution of water, rivalry for suitable sites with other uses, financing and entitlement obstacles, and other socio-economic factors will tend to slow the advances of aquaculture. On balance the industry is still likely to grow from the present ca. 13 per cent to between 20 and 25 per cent of the total world supply of directly consumed aquatic protein (wet weight) in the first quarter of the next century.

L'aquaculture et l'alimentation : opportunités et contraintes
L'aquaculture, c'est-à-dire l'élevage d'animaux et de plantes en eau douce ou salée, a connu durant les trente dernières années une croissance plus rapide que les pêches. Les stocks de poisson sont fortement exploités dans le monde entier et ils s'épuisent à certains endroits. On attend donc de l'aquaculture qu'elle fournisse une part croissante des protéines animales d'origine aquati-

que, surtout dans les pays où le poisson est une des bases de l'alimentation. L'introduction de techniques de croisement et, dans certaines mesures, de techniques biotechnologiques dans le domaine de la culture des animaux aquatiques, les progrès qui ont été réalisés dans l'alimentation artificielle de poissons carnivores et de crustacés, la limitation des maladies de ces organismes et un recours plus généralisé aux techniques du génie dans l'élevage des cultivars favorisera le développement de l'aquaculture dans le monde entier mais surtout sous les Tropiques où ce genre de culture conserve nombre des caractéristiques de métiers simples. La concurrence pour l'eau et la pollution de celle-ci, les rivalités avec d'autres usages dont font l'objet les sites appropriés, des problèmes de financement et de propriété juridique ainsi que certains autres facteurs socio-économiques auront tendance à ralentir le progrès de l'aquaculture. Au bout du compte, il reste probable malgré tout que l'industrie passera des 13 pour cent qu'elle fournit actuellement à quelque 20 à 25 pour cent de l'ensemble des approvisionnements mondiaux en protéines aquatiques de consommation directe (poids frais) durant le premier quart du siècle prochain.

Michael Waldichuk
Industrial and Domestic Pollution in the North Pacific

Pollution in the North Pacific from both industrial and domestic sources is confined primarily to coastal waters. Contaminants in coastal waters are mainly from land-based sources, entering the sea through rivers, coastal outfalls, ocean dumping and spillages from shore facilities. The open ocean is contaminated by discharges from ships and by substances from land transported through the atmosphere by winds. Five classes of contaminants are considered as coming from industrial sources: (1) petroleum hydrocarbons; (2) halogenated hydrocarbons; (3) metals; (4) radionuclides; and (5) persistent solid wastes. There is evidence for a decline in some components of the first four classes, where there have been national and international restrictions on their uses. The inadvertent production and release of dioxins and furans from pulpmills using chlorine for bleaching has led to closures of crab, prawn and shrimp fisheries in the vicinity of these mills in British Columbia. The amount of persistent synthetic materials, such as fish nets, ropes and plastic bags, may still be increasing. These substances are known to entangle marine mammals, sea birds, fish, and sea turtles, and are a threat particularly to endangered species such as the monk seal and the green sea turtle. There may be some control on the discharge of these materials from ships with the entry into force at the end of 1988 of Annex V of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78). Domestic sewage affects use of coastal waters adversely. On the North American coast, the effect on fishery resources has been mainly closure of shellfish areas to harvesting due to high fecal coliform counts. Beaches with high concentration of fecal coliforms have been posted to warn bathers of the risk of respiratory and other infections. On the

Asiatic coast, sewage discharges have caused not only viral infections due to consumption of contaminated seafood, but also eutrophication and red tides from over-enrichment of coastal waters by nutrients from sewage. International conventions and treaties, coupled with national legislation, have played a role in reducing concentrations of petroleum hydrocarbons, certain organochlorine compounds, e.g., DDT and PCBs, metals (mainly lead and mercury), and radionuclides in the marine environment.

La pollution domestique et industrielle du Pacifique nord

La pollution du Pacifique nord par des effluents industriels et domestiques est principalement limitée aux eaux côtières. Les produits qui contaminent ces eaux proviennent surtout de sources terrestres et ils parviennent à la mer par l'intermédiaire des cours d'eau et des décharges côtières ainsi que lors des déversements volontaires et accidentels dans l'océan causés par des installations côtières. La haute mer est contaminée par les produits que rejettent les navires et par des substances venues de l'intérieur des terres que les vents transportent dans l'atmosphère. On estime que cinq catégories de contaminants proviennent de sources industrielles : (1) les hydrocarbures de pétrole; (2) les hydrocarbures halogénés; (3) les métaux; (4) les radionucléides; et (5) les déchets solides persistants. On constate une diminution de certains des éléments des quatre premières catégories là où leur utilisation fait l'objet de restrictions nationales et internationales. La production et le rejet accidentel de dioxines et de furanne par les usines de pâtes qui blanchissent le papier avec du chlore a forcé la fermeture de zones de pêche aux crabes et aux crevettes situées à proximité de ces usines en Colombie-Britannique. Il est possible que les quantités de matériaux synthétiques persistants tels que les cordages et les filets de pêche ainsi que les sacs en plastique continuent d'augmenter. On sait que les mammifères marins, les oiseaux de mer, les poissons et les tortues de mer se prennent dans ces objets qui constituent surtout une menace pour des espèces en voie d'extinction comme le phoque moine et la tortue de mer verte. L'entrée en vigueur à la fin de 1988 de l'annexe 5 de la Convention internationale pour le prévention de la pollution par les navires de 1973, qui fut modifiée par le Protocole de 1978 (MARPOL 73/78), débouchera peut-être sur une certaine limitation des rejets de telles substances par les navires. Les effluents domestiques évacués par les égouts exercent quant à eux des effets négatifs sur les eaux littorales. Sur la côte nord-américaine, les conséquences du rejet de ces effluents sur les ressources halieutiques tiennent principalement à l'arrêt de l'exploitation des crustacés dans certaines zones à cause de la présence d'un trop grand nombre de coliformes fécaux. Des panneaux avertissant les baigneurs du danger d'infection respiratoire et autres ont été installés sur les plages présentant les plus fortes concentrations de coliformes fécaux. Sur la côte asiatique, les effluents des égouts sont à l'origine non seulement d'infections virales causées par la consommation de produits de la mer contaminés, mais aussi d'une eutrophication et de marées rouges produites par un surenrichissement des eaux côtières par les éléments nutritifs contenus dans les eaux d'égout. Des traités et conventions internationales, conjugués à des

mesures législatives nationales, ont contribué à réduire les concentrations d'hydrocarbures de pétrole, de certains composés organochlorés comme le DDT et les BPC, de métaux (surtout le plomb et le mercure) et de radionucléides dans le milieu marin.

Gordon A. McBean
Possible Impacts of Climate Change on the North Pacific Ocean and its Marine Resources

The marine resources and the climate of the North Pacific Ocean have each evolved through time and through their mutual interaction have resulted in the present situation. The North Pacific Ocean is generally less saline and more stably stratified than the North Atlantic Ocean; this leads to slower interaction between the surface and deep waters. Due to increasing concentrations of carbon dioxide and other greenhouse gases in the atmosphere, it is expected that the climate will warm over the next century. The oceans play a major role in the climate system, as a sink for carbon dioxide, a store for heat, and a major delaying factor in the rate of climate change. For doubled concentrations of greenhouse gases, the North Pacific Ocean is expected to warm by 1.5 to 2.5°C, with much greater warming occurring over the ice regions of the Bering Sea in winter. Changes to the position and intensity of the Aleutian low are also expected.

These changes in the climate are expected to cause the global mean sea level to rise 65 cm by 2100. Sea level rise, a warmer ocean and changes in the winds and precipitation will all have impacts on the ecosystem. Particularly vulnerable are the coastal regions and sensitive species.

Incidences éventuelles de la modification du climat sur le Pacifique nord et sur ses ressources marines
Les ressources marines et le climat du Pacifique nord ont évolué au fil du temps et la situation actuelle résulte de leur interaction. Le Pacifique nord est généralement moins salé que l'Atlantique nord et se caractérise par une stratification plus stable; les interactions entre les eaux de surface et les eaux profondes sont donc plus lentes. Parce que les concentrations en dioxide de carbone et autres gaz à effet de serre augmentent dans l'atmosphère, on s'attend à ce que le climat se réchauffe au cours du siècle prochain. Les océans jouent un rôle essentiel dans le système climatique puisqu'ils absorbent du dioxide de carbone, accumulent de la chaleur et constituent un important facteur de ralentissement du rythme de l'évolution climatique. Si les concentrations de gaz à effet de serre doublent, le Pacifique nord devrait se réchauffer de 1,5 à 2,5 °C, le réchauffement étant nettement plus marqué en hiver dans les régions glacées de la mer de Béring. On s'attend également à ce que la position et l'intensité de la dépression des Aléoutiennes soient modifiées.

Ces changements climatiques devraient élever le niveau moyen de la mer de 65 centimètres d'ici l'an 2100. L'élévation du niveau de la mer, le

réchauffement de l'océan et les modifications du régime des vents et des précipitations auront un effet sur l'écosystème. Les régions côtières et les espèces sensibles sont particulièrement vulnérables à cette évolution.

Warren S. Wooster
Marine science and resources: international issues and opportunities

Use of the ocean and its resources faces both natural and jurisdictional constraints. Both marine scientific research and fishery management were affected by the 1982 Convention on Law of the Sea and particularly its creation of an Exclusive Economic Zone. Better arrangements for international scientific cooperation now seem necessary not only because of the new legal constraints but also because of a growing realization that marine science and its applications to studies of climate change, fisheries, and marine pollutuion are all inextricably intertwined. Of particular interest is consideration of the possible consequences of predicted climate change on the distribution and abundance of fish stocks.

Effective scientific cooperation requires participation of scientists from all the relevant disciplines, laboratories, institutions, and countries involved. It is particularly needed to produce objective scientific assessments that can be used in policy and management decisions. Existing regional marine science and fishery organizations in the North Pacific are inadequate for the issues now at hand. Some general principles concerning geographical coverage, degree of specialization, degree of formality, and effects of linkages with national agencies are relevant. In the North Pacific, the near future should see development of a new multidisciplinary marine science organization, often referred to as PICES, as well as a broad-based fishery management organization concerned with the full set of interacting species exploited in the region.

Océanographie et ressources : Questions et perspectives internationales
L'exploitation de l'océan et de ses ressources se heurte à des limites à la fois naturelles et juridiques. La recherche océanographique ainsi que la gestion des pêches ont été affectées par la Convention de 1982 sur le droit de la mer et plus particulièrement par la création des zones économiques exclusives. Il semble maintenant indispensable d'instaurer de meilleures conditions de coopération scientifique internationale non seulement à cause des nouvelles contraintes juridiques mais aussi parce que l'on se rend de plus en plus compte que l'océanographie et ses applications dans les domaines des études halieutiques, de la pollution marine et de l'évolution du climat sont inextricablement liées. L'analyse des conséquences éventuelles du changement climatique prévu sur la répartition et l'abondance des stocks de poisson présente un intérêt particulier.

Une coopération scientifique efficace nécessite la participation de scientifiques de toutes les disciplines pertinentes et de tous les laboratoires, les institutions et les pays concernés. Il est particulièrement indispensable de réaliser des évaluations scientifiques objectives sur lesquelles on peut fonder

les décisions de politique et de gestion. Les organisations halieutiques et océanographiques régionales qui œuvrent déjà dans le Pacifique nord ne sont pas en mesure de faire face aux problèmes actuels. Certains principes généraux en rapport avec la couverture géographique, le degré de spécialisation, le degré de structuration officielle et les effets des rapports entretenus avec les agences nationales sont pertinents. Dans le Pacifique nord, une nouvelle organisation océanographique multidisciplinaire souvent appelée PICES devrait voir le jour dans un proche avenir, tout comme une organisation de gestion des pêches regroupant de nombreux pays qui s'occuperait de toute la gamme des espèces interdépendantes qui sont exploitées dans la région.

Symposium:
WOMEN IN SCHOLARSHIP: ONE STEP FORWARD, TWO STEPS BACK?

Colloque :
LES FEMMES ET LE HAUT SAVOIR : UN PAS EN AVANT, DEUX PAS EN ARRIÈRE?

SUSAN MANN TROFIMENKOFF, F.R.S.C.*

Introduction†

As part of its commitment to the advancement of women in all scholarly endeavours, The Royal Society of Canada sponsored a panel discussion of "backlash", the mildest of terms for the most horrible of happenings: the murder of fourteen women students at Montreal's École Polytechnique on 6 December 1989. The panel was to be an intellectual tribute to the slain young women and an exploration of the nature of backlash, its possible causes and cures. The title for the panel reflects the profound discouragement of the organizers, reeling in mid-winter from the monstrous threat to women's hard-won academic positions. As individual scholars had they been allowed solo flights into academe only to have the next generation, numerous enough to be flying in formation, gunned down? Beneath the liberal rhetoric of talent and merit, was this really what we were up against? Were universities, once seen as safe havens for women (indeed as escape routes from domesticity), places where the major social revolution of the twentieth century — that of the relations between the sexes — could be analyzed, understood, even promoted, now to be a literal battle-ground in that very revolution? The questions remain even as the next contingent of would-be women engineers turns up in even greater numbers (25% of the entering class) at the École Polytechnique in September 1990. Will their steadily increasing numbers be a guarantee of safe passage? And will those numbers change the practice or the theory of engineering?

Seven scholars from different disciplines shared their personal and professional reflections on the meaning of 6 December . As the following selections indicate, the reflections varied according to physical or occupational proximity, personal predilection, and feminist analysis. There even is a discernible male/female difference in the presentations: the two men are far more personal and perplexed than the women; they look to individual psychology for causes and solutions. The women are, on the whole, more analytical and wide-ranging. They draw upon two decades of feminist scholarship in Canada

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and elsewhere, scholarship that has renewed historical, literary, sociological and political studies, has initiated an entirely new field of intellectual enquiry — women's studies — and, in combination with numbers (of women students and professors) appears to be making its most public impact on legal studies. The fields most stubbornly resistant to the new scholarship are science and engineering. Is there something peculiarly masculine about those fields? Marc Lépine certainly thought so, in what too many people would still prefer to see as the isolated act of a twisted mind. But supposing the fields themselves, science as developed and practised since the 17th century, are fundamentally inimical to women? Their presence then becomes presumption and patriarchal societies have always dealt harshly with women's presumptions.

But there is no reason that this should always be so. Individuals are taking steps through heart-rending self-analysis. Institutions are taking steps with complex programs of employment and education equity. Academics, however, have largely left the scholarly analysis to the women and it may be time to redress that balance too. For we will need all our brainpower to understand the mechanisms of resistance, some of which may be built into our very ways of perceiving the world. Illustrations of both the drawbacks and the promise are contained in the following papers.

The Royal Society of Canada would be as good a place as any to start the work. The fundamental question is clear, posed plaintively and poignantly by a male member of the panel: "Why can't men, operating with the plainest conceptions of fairness, accept for women — for that is all that is involved — what they take for granted for themselves?" And by extension, why does that lack of acceptance entail backlash and violence? A research agenda to answer that question and put the answers into practice could be as daunting and certainly as significant as the entire global change program of the international scientific community. Items for the agenda, explicit and implicit in the papers presented here, include the following:

- science and technology as male domains;
- the masculinity of the workplace: structures, norms, behaviour, communication;
- male power of naming (and therefore of excluding): from children to facts;
- the education of boys;
- the myths and norms of male/female relations: how we live with them, how we live up to them, and how we try to change them;
- fear and hatred of women;
- relationship of numbers of women to acceptance/rejection of them;
- the meanings and purpose of feminism, for men, for women;
- the means of feminism: can a non-violent social revolution succeed?;
- the meaning of security, for men, for women;
- notions of sexuality;
- how some of the most admirable traits of a liberal society (justice, fairness, liberty, equality, reasonableness) could have come from and be intended for only one group of people;

- how to 'read' society, the way one learns to read literary or artistic 'texts' in order to decode the 'sub-text' of hostility to women.

While awaiting answers to these questions, the panelists unanimously pointed to universities as part of the solution. Not only should much of the research go on there (albeit in a more interdisciplinary and inclusive manner) but so too should the implementation of immediate change. It behooves our institutions of higher learning to abet change, to provide a positive environment for women, an encouraging milieu for feminist scholarship and to communicate that support to all members of the university community. Why not have an index of well-being for women in universities, suggests one panelist. The university should be constantly probing how and what things are taught, what concepts underly professional training, who is meritorious and why, whether the imagination of its young scholars is (in Ursula Franklin's vivid metaphor) being mortgaged to the granting agencies. And we must all recognize the contribution to scholarship made by all the women who work in any capacity at and for a university.

It is not just because the panelists are all scholars working in universities that they suggest these research questions and practical proposals. Rather, their training for and experience in intellectual problem-solving has been profoundly shaken by the tragedy at École Polytechnique. This happened in a university. Among the reverberating shock waves, which we do not even know how to measure, is the disturbing recognition that universities may in some way be responsible — and not just in their security systems.

My thanks go to Dean Marilyn Marshall of Carleton University for the original idea, to the Women in Scholarship Committee of The Royal Society of Canada for its willingness to foster and implement the idea, and to my colleagues on the organizing committee: Elizabeth May, Marilyn Marshall, Stephen Richer and Sanda Rodgers. Staff at the Society, notably Cathryn Bjerkelund and Linda Vachon, were immensely helpful.

LOUIS COURVILLE*

J'ÉTAIS LÀ†

My talk will have three parts. First, a few words about the École Polytechnique de Montréal; secondly, a few aspects of what it was like on December 6th, 1989; and last, three questions that I would like to raise.

École Polytechnique is an engineering school affiliated to the Université de Montréal but administratively independent. The École was founded in 1873; its first program of study was written by Charles Phister, an Alsatian who had been teaching physics and chemistry at Collège de Terrebonne in Quebec. He developed the program at the request of the Montreal Chamber of Commerce. Charles Phister opened the first class with four students and three part-time lecturers. At about the same time, at least three other engineering schools besides the École Polytechnique opened in Canada: at McGill University, at the University of Toronto, and, I believe, in Nova Scotia.

When I did my undergraduate studies, 1952-1957, we were approximately 600 students, all males. I believe the first woman graduated in 1959.

Today, the school has over 3,500 full-time students distributed in ten undergraduate programs in engineering. We also have over 1,000 graduate students among whom there were about 240 Ph.D. candidates last fall. This enrolment makes École Polytechnique the largest engineering school in Canada, both at the graduate and the undergraduate level. Of the student numbers about 600 are women; women constituted 15% of the graduating class this year, among the highest percentage in Canada, if not in the whole of North America. This is lower than in some European countries but in North America I think it is about the largest. In the past couple of years the percentage increased by approximately 1% per year. In the freshman class of Autumn 1989 it was 19%, and if we judge from current admission applications it will jump to 23% next September.

La présence des femmes n'est pas aussi élevée si nous considérons le corps professoral. Nous avons huit femmes qui enseignent à plein temps sur un corps de 220 membres, ce qui est légèrement inférieur à 4%. Il y un décalage

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† Présenté au colloque, «Les femmes et le haut savoir : Un pas en avant, deux pas en arrière?», University of Victoria, le 3 juin 1990.

d'environ quinze ans entre le pourcentage chez les professeurs et celui chez les étudiants.

December 6th, 1989, was the last day of the fall session before the final exams. The ninth class period goes from 16:45 to 17:35. There were more than twenty classes in full session at that time, many labs were in operation, and many offices were still open even though we normally close at five o'clock. I estimate that there were more than 2,000 people in the building.

The media has given many reports of the events at École Polytechnique and I do not want to repeat what you already know. What I want to stress is that during the ten minutes of Marc's rampage, 17:10 to 17:20, I really did not know just what was going on. I was in my office in a meeting with four other persons. A student came running in shouting that somebody was firing; he closed and locked the door. We did not have time to register what he had said, much less ask him what he had seen, when we heard many shots in the corridor nearby, then from the cafeteria directly under my office, and a few moments later from classroom A311 directly over my office.

I telephoned the police who had already been alerted. Then I tried, without much success, to communicate by telephone with various departmental offices. I tried to speak with the police through the office window that opens onto the front entrance of the building. They had cordoned off the building, but I still could get no clear information as to what was happening. Obviously it is not normal to hear shots firing around your office. You know that something very serious is happening but you are unable to grasp what it is. Simultaneously I wondered, was it a hold up? No, too many shots from too many directions. Was it a kidnapping? Or, more likely, a terrorist attack? Then the question in my mind was what could they possibly want? Unfortunately Marc Lépine did not ask for anything; he had prepared his act carefully, he had come to kill as he had stated very clearly in his letter.

One thing I have learned is that we need a much more effective emergency communication system in case of crises. In an emergency the first thing that is necessary is to know what is going on and be able to tell people how to protect themselves. I was not able to do that. I wonder why few universities have such a system.

J'aimerais terminer cette brève présentation par quelques questions pour lesquelles je n'ai pas de réponse.

1. How is it possible to have in the same person the coexistence of seemingly normal behaviour and, at the same time, the will and the capacity to plan meticulously such a mad and monstrous act? From one point of view Marc Lépine was certainly mad and sick, but at the same time he was rational, calm, deliberate, and monstrously effective. Je ne suis pas psychiatre et je ne sais pas comment répondre; je n'ai pas entendu non plus de réponse satisfaisante.

2. Que pouvons-nous faire pour dépister des individus potentiellement dangereux? How could dangerous persons be detected and positively identified? And this raises another group of questions which I am sure lawyers could wrangle over for a long time.

3. What kind of evidence would be necessary to tell a person who has not yet committed anything illegal: you are sick, you are a real threat to society, you need psychiatric treatment and you will have to submit to it even if you do not want to? This is a very difficult legal question that pits the rights of the individual against the right of society to protect itself. As engineers we have very little formal training even to suggest answers.

ROSE SHEININ, F.R.S.C.*

LA SUITE DU 6 DÉCEMBRE†

Sor Juana was persecuted by men who hated and feared women,
saw them as daughters of Eve and friends of the serpent,
permanent dangers to the soul.
Women in our day are oppressed,
on the whole, by men like them;
like them in their place.
Michael Wood[1]

Ce colloque est dédié au phénomène «un pas en avant, deux pas en arrière», phénomène qui semble accompagner la femme dans les arts, les lettres et les sciences. L'énormité de ce problème est souligné de façon aiguë par les événements du 6 décembre 1989 et de leurs répercussions.

How can the topic of this panel discussion be placed in the context of the happenings which surrounded, and continue to ensue from the massacre of fourteen women and the injury of eight others at the École Polytechnique, the Engineering School of the Université of Montréal? As engineering students, the young women were evidence that in Quebec, and in Canada, we had taken a huge step forward in a struggle in which we have participated individually, in groups, and collectively in society, for a very long time, but with special determination during the last thirty years. The ultimate goal of these efforts is represented by the *Charter of Rights and Freedom*, Part I of the *Canada Constitution Act*.[2]

Les jeunes filles décédées le 6 décembre représentent pour nous tous, de même que pour Marc Lépine, la promesse d'un changement fondamental des connaissances humaines. The young women of the École Polytechnique promised rapid change in the search for truth and knowledge, generally, and in particular, about engineering and engineers. Their numbers gave clear indication that the engineering workplace would be renewed in both theoretical and practical aspects. They provided a signal that we are moving towards a redefinition of women in society.

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† Presented at the symposium, "Women in Scholarship: One Step Forward, Two Steps Back?", University of Victoria, 3 June 1990.

Voilà le contexte du 6 décembre et la suite. C'est à nous maintenant de nous assurer que la mort des jeunes filles de l'École Polytechnique ne représente pas deux pas en arrière.

The events of 6 December are both unique and general. Their uniqueness we understand. And it was the uniqueness which was the focus of almost all initial media attention and analysis.[3] Les médias se sont servis d'hypothèses déjà bien connues pour expliquer un tel phénomène, que ces meurtres soient l'acte d'un pauvre jeune homme, dérouté, dérangé, sans doute fou, que ce zigouillage soit unique au point de ne pouvoir jamais le comprendre, ou bien, plus simple, que ce soit le résultat d'un foyer violent.

Having been exposed to the usual explanations for mass killings, we sadly and quietly return to our own thoughts and our everyday lives. Perhaps this time it will be different, especially for those of us who profess to be scientists and scholars, searching for the truth about ourselves and the world in which we live. Perhaps this time we will focus on an important fact which emerged from the words of Marc Lépine, who wrote that the massacre he was about to embark upon was because the targetted women had hoped to share a world previously reserved for privileged men.[4]

This concept of very separate and protected spheres of supposedly legitimate activity and domains of power for men and for women, is one which haunts every aspect of our lives. It is especially so in the realm of research and scholarship. It is a key feature of the academic ethos of universities. And it is especially important as we contemplate the events of 6 December: all but one of those killed and a majority of those wounded were young women at various stages of study for entry into the engineering profession, that self-proclaimed, last university frontier of machismo misogyny in Canada and elsewhere.[5]

It is crucial that we understand the entrenched sexism in academe, as we struggle in every scholarly discipline, to change the venue from one which is exclusive of women, to one which includes them. One cannot help reflecting on the origins of the philosophical constructs which render women invisibile, inaudible and inferior in a male world. There can, however, be no general significance to 6 December, without an appreciation that it constitutes one event in a continuum, a path which leads variously back to the font of our perceived, and received, authoritative knowledge. This is the knowledge which we recognize under the term "Western Thought", which continues to provide the theoretical underpinnings of modern science, philosophy, medicine, ethics, economics, work, etc.[6]

The trail of relevant knowledge traces back in recorded history to the writings of the ancient Hebrew sages.[7] It passes through and absorbs the classical "glory that was Greece and the grandeur that was Rome".[8] It moves forward in the words of the early Christian theologians.[9] And it follows on through the transformations of the Dark and Middle Ages, the Renaissance and the Enlightenment.[10] It carries into our own 20th Century in the modern concepts of Freudian penis envy and psychological castration.[11]

Time does not permit a profound analysis here of Western philosophical and scientific thought. However, it is clear to me that the key actor was and is

Aristotle (384-322 B.C.). For it was he who first elaborated a comprehensive, pseudo-scientific rationale to support his *a priori* constructs of the inferiority of women as compared with men.[12]

From an erroneous reading of Nature in general and of the biology of the human female and male and their sociological and behaviourial interaction in particular, Aristotle fashioned a misogynistic philosophy which permeates almost all the academies throughout the world. It is a philosophical construct which excludes women entirely from any legitimate participation in the search for, the generation of, and the application of human knowledge.

Not unexpectedly, Aristotle's vision of human behaviour evolved from, and provided a justification for the then-current practices of the slave society of which he was a product, and in which he was a participant, as a member of the ruling autocracy.[13] Consider the following quotations:

> ... therefore almost all things rule and are ruled according to Nature. But the kind of rule differs — the freeman rules over the slave after another manner from that in which the male rules over the female, or the man over the child.[14]

> Again, the male is by nature superior, and the female inferior; and the one rules and the other is ruled; this principle of necessity extends to all mankind.[15]

> The fact is, the nature of man is the more rounded off and complete, and consequently in man the qualities or capacities above referred to are found in their perfection.[16]

Thus, Aristotelian vision insists that man is perfect, woman imperfect. Therefore the male is superior, the female inferior. And so man must rule, woman obey. Man is fertile in thought and seed, woman is but a receptacle. Man has wisdom, woman does not. Man is rational and capable of ruling whereas woman is irrational and therefore without authority. Man may take his natural place in the public sphere, and have public opinions, whereas women are to remain silent in their private lives. By such teachings, Aristotle created a theoretical framework for the *de facto* separate sphere of action, influence and power for men and women, already in place for some 10,000 years.[17]

Ce n'est pas facile de comprendre la situation des femmes dans la science et l'érudition, si on ne se rend pas compte du lien entre les premières universités et la philosophie aristotélienne. Au cœur de cette histoire on trouve le saint Thomas d'Aquin et ses collègues, les maîtres de l'Université de Paris.[18] The Université de Paris served as the model for all others in Europe, and in South and North America, including our own here in Canada. It emerged in the late 12th century from the Cathedral School of Notre-Dame in Paris, under the guidance of the Bishop of Paris. The tradition of higher learning and education of men and women had been enshrined in monastic Benedictine teaching institutions for the training of the clergy and the education of the men, and

some women, of the nobility. By 1210, this tradition had been transformed into a classical Augustinian university manned for males, by male monks who were made legitimate as the first, all-male Guild of Masters, by Papal Bull. By 1215, this guild was enshrined by statute, as an undergraduate Faculty of Arts and Letters of the Université de Paris. In 1214 the very same Bishop of Paris founded the University of Oxford in England. These primordial universities shared their masters, their studies and their philosophies. And it is these two universities which have carried forward to us the double French and English academic traditions we have today.

The Guild of Masters, or the professoriate of the early universities, was modelled on a male conception of knighthood and clearly to the exclusion of women. By 1231, the Masters and students of the Universities of Paris and Oxford were entirely ecclesiastics. More to the point, by 1254 eighty percent of all teaching posts were held by monks, many of whom were cloistered away from all contact with normal society. Of key significance for the present discussion is the fact that in 1255, by Papal law, women were entirely excluded from the Université de Paris, the "first School of the Church" and "the cherished daughter of the King", Charles V. The Papal Bull made mandatory all of Aristotle's teachings — the direct result of the influence of Saint Thomas Aquinas. Specified in law were Aristotle's *Logic* to replace the teaching of grammar and rhetoric in the Faculty of Arts. Also included were the *Physica* and *Meta-Physica, De Animalibus, De Caelo et Mundi, Ethics* and the *De Anima*, to be taught in the graduate Faculties of Theology, Law and Medicine, as the sole and obligatory curriculum.[19]

And so it was that Aristotelian thought, so inimical to the status of women in our academies, was institutionalized and came to dominate all authoritative and accepted philosophical thought, even down to the present, even down to Marc Lépine. This influence was felt deeply and broadly in all domains of natural philosophy and science, in moral and mental philosophy and ethics, in legal theory and practice, in economics and sociology, and in history.

In the context of this panel discussion our response and memorial to December 6th should be to answer the question posed recently by the philosopher, Hilde Hein[20]:

> How have philosophers made the principle of male superiority appear intellectually acceptable — as a state of affairs which not merely was, but **should be?**

Perhaps we can do this when we appreciate her analysis that,

> Philosophical explorations are not demonstrations of fact, direct or indirect, but are rather attempts to fit such accounts of fact into a rational framework, in terms of which the facts seem "correct", "necessary", "inevitable" or better yet, "in accordance with Nature".

As scientists and scholars, we would be wise to return to some of the words of Francis Bacon. For example,

> Thus it happens that human knowledge, as we have it, is a mere medley and ill-digested mass, made up of much credulity and much accident, and also of childish notions which we first imbibed. [...] there is no hope except in a new birth of science; that is, in raising it regularly up from experience and building it afresh; which no one (I think) will say has yet been done or thought of.[20]

Our task in examining the question raised by this colloquium is profoundly challenging. It is to confront honestly, and with intellectual and moral determination, the theoretical underpinnings of the apparent reality of women in society, as well as in scholarship: that just as we stretch forward one more step to the truth, we find ourselves being pulled and pushed two steps back. The challenge for those of us who seek knowledge and truth, is to confront some ten thousand years of misogynistic practice and theory. It is to transform our base of human knowledge according to the model encapsulated in the quotation from Bacon.

Donc, en fouillant nos connaissances dans le but d'y inclure les femmes, nous devons faire disparaître des siècles d'information erronnée et de formulations misogynes, qui ont contribué aux événements du 6 décembre 1989.

ENDNOTES

1. Michael Wood, "The Genius of San Geronimo", *The New York Times Review of Books* 35(15) 13 October 1988, pp. 39-43.
2. Government of Canada. *The Canadian Charter of Rights and Freedom.* PT.I. *Constitution Act*, 1982. C.11 (U.K.).
3. Louise Malette et Marie Chalouh, éds., *Polytechnique, 6 Décembre* (Montréal: Les éditions du remue-ménage, 1990).
4. Marc Lépine, cited in "The constructive challenge of feminism", *The University of Toronto Bulletin*, 22 January 1990, p. 16.
5. Patrick Quinn, "Anti-feminist resurgence is troubling", *The Toronto Star*, 20 July 1990, p. F1.
6. Geneviève Lloyd, *The Man of Reason: "Male" and "Female" In Western Philosophy* (Minneapolis: University of Minnesota Press, 1985).
7. Moshe Meiselman, *Jewish Woman and Jewish Law. Library of Jewish Law and Ethics*, Volume 6 (New York: KTAV Publishing House, 1978); Leonard Swidler, *Women in Judaism. The Status of Women in Formative Judaism* (Metcuhen: Scarecrow Press, 1976); Judith Plaskow, "Blaming Jews ... for the birth of patriarchy". *Lilith* 7 (1980), pp. 11-13.
8. Mary B. Mahowald, ed., *Philosophy of Woman. Classical to Current Concepts* (Indianapolis: Hackett Publishing Co., 1983), pp. 43-89.
9. Prudence Allen, *The Concept of Woman. The Aristotelian Revolution, 750 BC - AD 1250* (Montreal: Eden Press 1985).

10. Linda A. Bell, ed., *Visions of Women. Being a Fascinating Anthology of Philosophers' Views of Women from Ancient to Modern Times* (Clifton, NJ: Humana Press, 1983). See also G. Lloyd, M.B. Mahowald, *op. cit.*; Edwin A. Burtt, ed., *The English Philosophers from Bacon to Mill* (New York: Modern Library, 1967); Ian Maclean, *The Renaissance Notion of Woman. A Study in the Fortunes of Scholasticism and Medical Science in European Intellectual Life* (Cambridge: Cambridge University Press, 1980).
11. Juliet Mitchell, *Woman's Estate* (New York: Random House, Vintage Books, 1973), pp. 159-172.

    "The Constructive Challenge of Feminism". *The University of Toronto Bulletin*, 22 January 1990, p. 16.
12. Maryanne Horowitz, "Aristotle and Woman", *Journal of the History of Biology* 9 (1976), pp. 183-213; Linda Lange, "Woman is Not a Rational Animal: On Aristotle's Biology of Reproduction", in Sandra Harding and Merill Hintikka, eds., *Discovering Reality* (Dordecht: Reidel, 1983), pp. 1-15; Richard McKeon, ed., *The Basic Writings of Aristotle* (New York: Random House, 1941); See also M.B. Mahowald, *op. cit.*
13. Alban D. Winspear, *Lucretius and Scientific Thought* (Montreal: Harvest House, 1963).
14. Aristotle, *Politics* 1260a 4-12. Cited in P. Allen, *op. cit.*, p. 113.
15. Aristotle, *Metaphysics* 982a 17-19. Cited in P. Allen, *op. cit.*, p. 113.
16. Aristotle, *History of Animals* 608b 6-14. Cited in P. Allen, *op. cit.* p. 118.
17. P. Allen, *op. cit.*, pp. 413-473.
18. *Ibid.* See also Rose Sheinin, "Women in Science: Issues and Actions", *Journal of Canadian Woman Studies* 5(4) (1984), pp. 70-77; Rose Sheinin, "Women as Scientists: Their rights and obligations", *Journal of Business Ethics* 8, Summer 1989, pp. 131-155.
19. P. Allen, *op. cit.*, pp. 413-473.
20. Hilde Hein, "Woman — a philosophical analysis", *The Holy Cross Quarterly* 4(4) Fall 1971, pp. 18-23.
21. Francis Bacon, *Novum Organum, The New Organon: Or True Directions Concerning the Interpretation of Nature*. Aphorism XCVIII, cited in E. Burtt *op. cit.*, pp. 67-69.

PETA TANCRED*

HARASSMENT AND "BACKLASH": COMMON THREADS, ANY SOLUTION?†

There is a recent and strong negative stance against the presence of women in our universities. We do not have to look very far for evidence: the continuing minimal and, in some cases, decreasing presence of women professors; the slowness of academia in integrating two decades of second-wave feminist scholarship into its traditional frameworks; the minimal financial investment in women's studies degree programs; so-called student "pranks" in various universities which diminish female colleagues in various ways; sexual harassment at all universities as an on-going problem; and, finally, the horrifying massacre of fourteen young women at the École Polytechnique of the Université de Montréal in December of 1989, which constitutes the most extreme symbol of widespread antagonism towards women. As this listing suggests, I see these examples as various forms and degrees of antagonism against women — either intellectual antagonism through the diminishing and excluding of feminist scholarship, or physical antagonism whose horror has become all too familiar to us since last December 6th.

The term "backlash" is often used to describe this negative stance towards women's academic presence. I find the term an uncomfortable one for it denotes a reaction to some social development (according to Webster), as if the original impetus came from women's action. I think we would agree that this is a rather short-sighted reading of the historical context. The current antagonism is not the result of women's action, but is embedded in a society in which women's unequal position has been a deplorable form of haemorrhage of society's talents and strengths over the centuries.

Women's presence in academia is not, of course, the only example of women's entry to what the sociologists euphemistically call the "non-traditional" occupations, and I want to call on some recent research on workplace

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harassment — one of the forms of antagonism that I have mentioned — which provides some general illumination about antagonism towards women. The frequent view of harassment is that men in power positions harass women in subordinate positions, exchanging organizational advantages for sexual favours. This is termed "*quid pro quo*" harassment in the literature[1] and it is, indeed, a widespread form of harassment, in which women are treated as sexual objects within the context of a clear power hierarchy.

Less well know is a second form of harassment, sometimes termed "atmosphere" harassment[2] which takes place in situations of approximate power equality and usually within the context of non-traditional occupations. This form of harassment aims not to exchange favours for advantages, but rather to render the work context intolerable for the minority of women who have entered the occupation. It is also designed to reaffirm male power in what is considered to be a traditional masculine domain. The harassment emphasizes the masculine atmosphere of the workplace in various ways: sexualized language and graffiti indicate clearly to women that they do not belong; "joking" sexual advances are used to taunt or intimidate women; jobs are constantly defined as non-feminine and therefore inappropriate for women; pervasive swearing communicates clearly that women have no place in the workplace. Any general impressions to the contrary, this is the most pervasive form of harassment; it is much more frequent and virulent than the first form of harassment. In a recent collection of writing on sexuality in organizations, my colleague Nancy Di Tamaso argues that it is women who work in male-dominated occupations who are "most likely to become conscious of the sexualization of the workplace in the form of both sexual harassment and sex discrimination".[3] Gutek and Morasch support this finding with their observation that three-quarters of their women subjects in the Los Angeles area in non-traditional occupations reported sexual harassment compared with half the women in their total survey.[4]

Because the results of this research come from studies of manual occupations, and emphasize overtly sexual ways of harassing women, we tend to ignore their relevance for other kinds of non-traditional occupations. However, if we talk of gender rather than sexual harassment, it is easier to generalize such results. Is it useful to translate this second form of "atmosphere" harassment into areas of non-manual occupations? I would argue that it is, for it underlines the common threads running through overt sexual harassment of women in manual occupations, and the more general forms of gender harassment that are present within non-manual contexts. The comparison also illuminates the fact that, in both cases, we are talking about power — the traditional power of males to define certain occupations as appropriate for their gender only, and the very extreme means, on occasion, that are used to underline this reality.

For the events of December 6th underline one fact that in all the journalistic and other writings on the subject has not been highlighted sufficiently in my view. Here I refer to the fact that Marc Lépine, in attacking what he termed "une gang de féministes", had his own personal definition of feminists — one

that was not shared by the women at École Polytechnique, as illustrated by one woman student's plaintive attempt to explain to him that women students at the school were not necessarily "feminists". It is also a definition that would not be shared by the vast majority of feminists that I know. For the definition that Lépine had in mind was that feminists were women in non-traditional settings, "qui ne sont pas à une place habituelle, à l'endroit où on les trouve habituellement".[5] Lépine did not select a course in women's studies in a social science faculty, where he might have found not only more women, but also more women who defined themselves as feminists; such a setting has become too "traditional" for women for his definition of feminism. Instead, the entry of women into the traditional male preserve of engineering, that is a non-traditional setting, constituted his definition of "feminism".

From what I have said, it follows inevitably that I would like to see the research on "atmosphere" harassment extended to the non-manual arenas; I think a focus on the affirmation of the masculinity of the workplace would bring out additional dimensions to those which are already being highlighted in general studies of women in management and the professions. The negative stance towards women in academia should be seen as part of this "atmosphere" harassment. For there is every indication that universities are not a welcoming environment for women and, in fact, one of the most disturbing recent developments is that women with appropriate qualifications are starting to reject university openings, for they want no part of such a workplace.[6] I would like to see research in a complementary vein, on what could be done to render universities more positive environments for women. Many of us have put forward the obvious suggestions, such as day care facilities, recognition of differential career patterns, part-time programs and so forth,[7] and these must be taken seriously. But there are many subtle means of making women more welcome in universities, and the women themselves should be asked about them.

Finally, there are some intriguing data that suggest that the non-traditional work setting becomes a variable in itself which should be investigated further. For example, *Le Devoir Économique* (May 1990) cites a doctoral thesis from the University of Ottawa which suggests that resistance to women in management is not a straight line phenomenon. Instead, as women become more than a third of the appropriate work group, resistance to women's presence, previously accentuated, starts to diminish. Is this also true of universities and is it part of the answer? Variations amongst faculties might facilitate the investigation of this research question; but a more general approach to the question will require a significantly higher proportion of women in the faculty and graduate student ranks and for this, as I have indicated, the universities must explore the means of providing a more attractive environment for women candidates.

ENDNOTES

1. Catharine A. Mackinnon, *Sexual Harassment of Working Women* (New Haven and London, Yale University Press, 1979).
2. Peggy Crull, "Searching for the Causes of Sexual Harassment: An Examination of Two Prototypes", in C. Bose, *et al.*, *Hidden Aspects of Women's Work* (New York: Praeger Publishing, 1987).
3. Jeff Hearn, Deborah L. Sheppard, Peta Tancred-Sheriff, and Gibson Burrell, *The Sexuality of Organization* (London: Sage, 1989).
4. Barbara Gutek and Bruce Morasch, "Sex-Ratios, Sex-Role Spillover, and Sexual Harassment of Women at Work", *Journal of Social Issues*, 38:4, 1982, pp. 55-74.
5. Danielle Juteau and Nicole Laurin-Frenette, "Une Sociologie de l'horreur/See no Evil, Hear no Evil, Speak no Evil", *Sociologie et Sociétés*, 22:1, April 1990, p. 206.
6. The development is sufficiently recent that it is hard to document, but it was a major theme of the recent Senior Women Academic Administrators Conference, held in Montreal, 26-27 April 1990.
7. *OCUFA Forum Supplement*, May-June 1986.

I would also like to acknowledge the work of two students — Tena Wolters and Andrea Litva-Ormond — in my course on "A feminist perspective on organizations", whose work on sexual harassment has been very useful in the preparation of this paper.

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Harming Women: The Backlash to Feminism†

I

As a coherent cluster of reflectively articulated practices and, less steadily and less surely, as a theory informing and guiding those practices, feminism has become a powerful force in our time. That this has been largely confined to the upper strata of our class-structured and sharply stratified societies has not been firmly enough appreciated.[1] And even where it has made the most gains, as, for example, in the academy and in the professions, the gains have not been as clear cut as has been widely believed. Still, there have in Western societies been gains. There is a long way to trek before we can rest but we have gone some of the distance.

Even that little way has provoked a male backlash. I do not know how widespread it is or how powerful it is but that it is there is evident. And it is to this backlash that I wish to address myself. I shall try to say something about what it is and what its ranges are and, if I can, something about its underlying dynamics.

Let me say what I shall not do. I shall make no proposals about what will cure the situation. I do not know what we should do to prevent a repetition of acts like Marc Lépine's, at the one extreme, or the sexist remarks of some of our colleagues at the other. For the latter, we can show by our behaviour that we do not find them funny but what we can do to alter the underlying attitudes or the residues of such attitudes in ourselves is to me less than clear. Platitudinously, self-consciousness about this is important but it can only carry us part of the way or psychotherapy would be something that was not needed by people who can be tolerably conscious, at least at a certain level, about what ails them and yet be quite incapable of doing much about it. Whatever we do will be largely a bootstrapping operation; we must repair that ship at sea. Deep

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cultural and institutional changes are needed as to how we are to be reared as children, but (a) how do we get to that changed rearing as the cultural norm and (b) what form should this socialization take and (c) whatever is to be done concerning (a) and (b) is a long-term project but there is an urgent need for action now. I shall not say anything about these matters not because I think they are unimportant but simply because I have nothing unplatitudinous to say about them. I do not know what we must do to cure the ills that beset us. What at most I can do is to contribute a little more to our understanding of male domination and to the backlash on the part of males to the partially successful resistance to this domination: that is to say, the backlash to the challenge posed to this male domination by feminism. Perhaps if we understand this reaction better we can begin more adequately to understand how to cure this essentially misogynist deep human malaise.

Nothing that I say here has much, if any, relation to whatever expertise I may have as a philosopher. As a philosopher, I might proffer a typology of feminism, give a conceptual elucidation of what is meant by 'violence' or attempt to define rather more exactly what we mean by 'backlash' or to specify the relation of theory to practice *überhaupt* and, more specifically, in feminism. I will attempt none of these things. In not doing so I am not casting aspersions on these topics concerning which a philosopher might have some expertise. But I am given to understand that they are of less fundamental importance than some other issues we might address or questions that we might ask and that they are, as well, considerations of less urgency. It is these latter issues — issues I shall specifically characterize in a moment — that I shall address without reliance on anything like philosophical expertise and wishing very much that I knew more psychology, social anthropology, sociology and history than I do. I shall, feeling very inadequate to the task, lean on some of what I have learned from rather unsystematic reading and conversation and what I can draw from my own experience as a male in his mid-sixties formed in the rather minimally enlightened atmosphere of middle North America.

II

Men in all societies at all times in history have dominated women. In some places and times the domination has been more savage and/or more thorough than at others but, in one way or another, it has always existed and it continues to exist, though now at least in Western societies in somewhat more moderate and subtle forms.[2]

Social anthropology also teaches us that women in many places and at many times have found the means to fight back. However, their fighting back has often been much like the way many blacks and coloureds have fought back against their masters in South Africa, often subtly and resourcefully, but without the means or even the aim to overthrow the structure of domination. However, some women in the past decade or so in the more materially advanced and affluent societies, with women now extensively employed in the workforce, have begun not only to try to moderate this dominance, to find a bit of their own breathing space, a room of their own, so to say, but to attack

it forcefully with a view finally to overthrowing it, though, to use Antonio Gramsci's metaphor, it may be more like the long trench warfare of position than a straightforward frontal attack. But the intent, whatever the best tactics, is radically to alter human history by finally, once and for all, overthrowing, in the materially advanced parts of the world and eventually in the whole world, male domination and all its systemic effects, and to bring into being a genderless world.[3]

As capitalists have been very edgy in the face of aroused and determined revolutionary workers formed into revolutionary parties — no one likes to lose his privileges — so men are now edgy in the face of a powerful challenge by some women to their hegemony or of what some men perceive to be such a challenge.

Predictably, men react to this challenge or perceived challenge. So we have the backlash. It takes place in the job market (in reactions to affirmative action, for example) and in intimate face to face spousal or quasi-spousal relations. The two are not, of course, unrelated but it is the latter, I believe, which is the most persistent and the most resistant to revolutionary transformation. Perhaps I am mistaken about that last claim. It is rather impressionistic on my part and it may not be an accurate account. But I shall confine myself to what I take to be this more resistant element nonetheless. I shall start rather descriptively, and then I shall seek to look for something of an explanatory account of such phenomena.

Men, consciously, semi-consciously or unconsciously, have sought, with considerable success, to dominate women, to control them, to exert power over them, to keep them in their place, to keep them, as it has been crudely put, in the kitchen, barefoot and pregnant. We have from our Hebrew-Christian culture St. Paul's ideological slogan: "Women be subject unto thy husband like unto God". The husband, in such a conception, is to be the local surrogate for God. His wife, incapable of full rationality or full morality, is to live under his care and direction. The other central strand of our culture — the presumed rationalistic Greeks — were no better. There women were thought to be mere matter. Reflecting in a heightened way pervasive elements in their culture as ideologists typically do, Plotinous classically proclaimed that women are the befouling mirror of the divine. Misogyny in our own culture runs very deep and is very pervasive. In seeking to control women, men have had, probably as a psychological reinforcement, to denigrate and demean them in the course of their domination. This frequently leads to violence to women: 'keep the bitch in her place'. I will start with that.

On 6 December 1989, Marc Lépine murdered — gunned down — fourteen female engineering students at the Université de Montréal. This gruesome revenge was, as he conceptualized it, upon that bunch of feminists who had, as he saw it, ruined his life. I think that we should not see this as an isolated act of a madman but rather as an extreme form of something that is pervasive in our culture. Take, to give some empirical flesh to this, some current examples of verbal violence to women. Students at the University of Alberta responded to a fellow female student's protest against their sexist rituals by

sloganizing: *'Shoot the bitch'*. To a campaign by feminist students at Queen's University, sloganized around *'No means no'*, some male students counter-sloganized with *'No means now'* or *'No means kick her in the teeth'*. These are, of course, extreme forms of behaviour but it is now well known that sexual harassment and wife beating are widespread in our society. It cuts across all strata of society. It is not merely a phenomenon of the down and out and the ill-educated: people pressed against the wall. Some academics and professionals are wife beaters or sexual harassers. These even include men who despise macho attitudes and the John Wayne cult of the gun, replete with gunshop petitions protesting the castrating unfairness of the government's desire to make the purchasing of semi-automatic weapons illegal.

A central point I want to make here is that to fasten rather exclusively on Marc Lépinish phenomena is likely to trivialize the issue by leading us to believe that if we can just contain the crazies and the creeps we will have solved the problem of the backlash. Rather it seems to me that John Scott was not far off the mark when he closed his article, "The Men's Club: Rambo Ain't Heavy, He's My Brother", by remarking:

> It seems to me what men need is to summon up the courage and strength to accept Marc Lépine as a brother, a sibling, who was raised in the same toxic cultural environment and with whom we share a number of internalized values, beliefs, desires and fears. Lépine was not a free-floating cloud of pure radical evil but the extreme end of a line that runs through us all.[4]

Lépine's murdering of fourteen women, unfortunately, was not a senseless and incomprehensible act, but an all too comprehensible act, given the extent of misogyny and the perceived threat to male domination; a domination that carries with it a craving for power, a craving graphically symbolized in the silent man of action rendering justice not through the civility of discourse, but through direct and immediate action of the avenging power of his gun.[5] People of my age were brought up — importantly morally formed — by such cowboy films. Our reaction to the Montreal massacre is our — I speak here of men and not only of men of my generation — visceral recognition of the horrible familiarity of Lépine's act. It is this that is so deeply disturbing. To quote Scott again, Lépine "represented a tortured, inappropriate, archaic definition of masculinity as it attempts to deal with the frustration and limitations of its own loss of power".[6]

Ignoring the extreme types, let us see if we can gain a little better understanding of the male psyche as it responds to the social transformations engendered by feminism and by our changing material conditions of life. How can men be expected — predictably expected that is — to interact with growing female power in the world? Though note it is a quest for power which asks for no more than for a genuine equality of condition, a fraternity compatible with that condition, a respect for a full self-ownership along with an acknowledgement of our common human interdependency.[7]

III

For starters, and plainly, 'real men' — straight-shooting, inarticulate, strong and silent types — are out. The John Wayne types are by now cultural dinosaurs. But the cultural demise of the normative hegemony of the strong, silent, inarticulate man of principle as the ideal of male behaviour leaves men in a kind of normative vacuum. Moreover, it is a vacuum that brings with it anxieties. At the very time when many men are coming to feel very vulnerable, the rigid and restrictive norms of traditional masculinity are being abandoned, and with that their supporting social structures, producing at the extremes, among other things, Rambo-like fantasies. But it is the anxieties and related fantasies more along the cultural norm that should have the most attention, because they are so pervasive, so unnoticed and so resistent to change. They hardly are of sensationalist interest but they do deeply affect the lives of many people.

What are the anxieties that bedevil even men who are not macho types and who at least consciously do not want to dominate women? Why can't these men, operating with the plainest conceptions of fairness, accept for women — for that is all that is involved — what they take for granted for themselves and other males? These are just ways in which human beings — men and women — are to be treated by virtue of their very humanness. Why are men anxious or even frustrated by their spouses expecting them to share an equal burden of childrearing and domestic chores? Why are they upset if their wives, who have jobs of equal responsibility and that are equally as demanding, simply tell them that they will work late or be gone for a weekend at a business engagement or conference? These are things that they would routinely do themselves and not expect their wives to demur at or feel upset about or think that there is anything out of the ordinary. Why do they not easily accept a symmetry here: what is acceptable behaviour in one is acceptable behaviour in the other? There is no relevant difference between men and women which would justify or even excuse different treatment or a different structure of rights or legitimate expectations. But more than a few males feel threatened or are at least made unquiet by such autonomy or even the possibility of such autonomy for women, for the right for women to exercise a self-ownership that males take for granted for themselves.

I am not a psychologist and perhaps what I am about to say smacks of pop psychology. Throwing caution to the wind I shall persist. I think the sources of such attitudes are at least the following: (1) Men are possessive of what they take to be 'their women' and in such circumstances feel insecure in their possession; (2) Men want and expect to be cared for, to be taken care of, by 'their women'. They want women to be at their beck and call, to meet their needs and to subordinate their own. They want them there when they come home and they want them to look after them, to sympathize and to massage their not infrequently battered souls. It is deeply threatening to them that 'their women' could have an order of aspirations or even duties and obligations that in certain circumstances could override what men unselfconsciously take to be their due or what they think living together requires. Their system of

security is threatened: their conception of a comfortable world where they are looked after is threatened; (3) I think also that sexual anxieties are frequently involved. This, of course, is linked to possessiveness. But it is sufficiently distinctive to merit separate comment. If women are free to come and go as they please, to go as their work or indeed their inclinations dictate, what is to keep them from being in the arms of another and who is to know anyway if they are the least bit discreet? And men, understandably, feel very threatened by that. It strikes at their possessiveness and in some instances it threatens their macho-touched images of masculinity. There is the anxiety (generally repressed), at least with the macho types, that there may be a better gun in town than theirs. But even when such Rambo-like residues, however modulated, do not obtain, the possessiveness often remains. The thought that their wives or lovers may be giving themselves to another is deeply threatening.

I think that these men are in bad faith with women. They are projecting onto their wives or lovers things they would do, or wish to do, and sometimes do, without compunction or remorse. But if it is okay for them why is it not equally okay for their wives? Traditionally men have not tolerated that at all when they could do anything about it. Perhaps there was a time where, as David Hume argued, there was some kind of an approximation of a justification for such attitudes by way of linking paternity with property rights. That still seems to me outrageous as a justification for differential treatment of women. But at least it had a kind of unfair rationale. But in a world of advanced technology the concern about who is the real father to pass on the male line and to ensure that property rights remain as they should be is largely mythical. But where that does not pertain and where men do not feel any compunction about fidelity to their wives or lovers, why do they feel so threatened at the very idea of similar behaviour on the part of their wives or lovers? Is it a switch-over of guilt about their own behaviour, their own treatment of their wives? Is it the sexist parallel to the racist and sexist male slave ownership obsessions about the prodigious sexual powers of male black slaves? The slave owner had sexual access to his slaves' wives and daughters. Submerged guilt and fear led him to project the desire for recriprocal behaviour on the part of his slaves and there was, as well, the fear that if recriprocity were ever obtained, their own wives and daughters would find the slaves irresistible. Again there is the old anxiety about their own sexual prowess.

However, what about the male who aspires to fidelity to his wife or lover, and even those who succeed in their aspirations, who still feel such anxieties about their wives or lovers? They expect when they go away or have to work late that their wives or lovers will understand and trust them and they would deeply resent their not trusting them. Why do they not — again plainly the fair and reasonable thing to do — reciprocate that expected understanding and trust? If they expect their wives to trust them, why do they not take it that their wives can expect and have grounds for receiving a similar trust on their part? If anything is fair, that is.

There may be some men who will not reason in that way for they are carrying over, perhaps rather unwittingly, a very old mythical belief about

women, namely that with respect to moral powers as well as powers of reason women are not the equals of men.[8] Men are creatures of reason who govern themselves by moral principles.[9] Women are more subject to their passions and their appetites than men and so cannot be trusted as men can. This, until relatively recent, pervasive cultural myth was firmly believed by some very eminent and reasonable philosophers: Aristotle, St. Augustine, Locke, Rousseau, Hume, Kant and Hegel, to name some of the more prominent ones.[10] But for our time, for men with some tolerable understanding of the world and of people, no such stereotyping will be possible. To them such a conception will be both morally offensive and utterly unrealistic. Why then such unease and such non-reciprocity from many a male when his wife or lover trusts him and he has plain evidence that she loves him? It is natural enough that he will miss her when she is away for a weekend or even when they do not have dinner together. But why does this translate into unease and a lack of trust and, in turn, guilt about this lack of trust for he has very good reason indeed to trust her?

Yet even some such men will not find the resources within themselves to trust even when they know that they should. They know very well that it is a perfectly reasonable trust, and, as well, an elementary requirement of fairness and respect and they know that such trust goes with love between people. They also know very well that coerced fidelity is no fidelity at all, even if the behaviour that goes with fidelity can be secured. Yet, not a few males will continue guiltily to have feelings of jealousy and anxiety in acknowledging that freedom and having a trust in their wives that they would just routinely expect their wives to extend to them. The roots of this are neurotic — not something a man of reason should be possessed of — but they are there in not a few men. But neurotic though they may be, they are frustrating and frustration leads to aggression: sometimes relatively mild and sometimes not so mild. So here we have, from a descriptive point of view, what may be some of the explanation of the backlash.

IV

Feminism, rightly so, insists on full equality and equal rights of self-ownership and autonomy between men and women. Women here, and elsewhere, will have the same full range of rights that men do and they will, again rightly enough, insist on exercising those rights. Their equal access and participation in the workplace — something we are still only gesturing toward — carries with it responsibilities that will not make it possible, even if it were desirable (as it is not), for them just to be there at home waiting for 'their men', just there with the main object of their lives to care for them and to meet their needs. Women's lives, under contemporary circumstances, will be more varied and will not be centred so centrally — or indeed centred at all — on the care and nurturing of their lovers, husbands and children. This threatens men in the three dimensions I characterized — over their possessiveness, their need to be cared for and in their sexuality. This leads to anxiety and frustration on their part and people, as I also noted, who are frustrated tend to respond with aggression.

This gives rise to violence and to other forms of harm, subtle and not so subtle, to women.

From jealous husbands who burden their wives or lovers unnecessarily and unfairly in their living autonomously or more extremely make it a struggle for women both to live autonomously and stay with their spouses, to men who actually dominate and subdue their wives, to men who beat them to keep them in fear and subordination, to even more extreme acts of violence, there is, all along the line of a rather considerable continuum, a tense backlash against women: a backlash generated by the material circumstances of contemporary life and by feminism. But when we look at the matter soberly and fairly we must recognize that feminists have done no more than demand for women what is only theirs by right, by considerations of elementary fairness and by common human decency, where people are seen, as they should be, as equals, as self-owning but interdependent members of a Kantian kingdom of ends, where each is to count for one and none is to count for more than one. The backlash is plainly morally indefensible as is male domination of women and misogyny. To see this takes no fancy or complicated moral theory or indeed any moral theory at all.[11]

With the coming into being of a greater material affluence, with more education and the greater understanding that goes with that, and with the resultant shifts of socialization, will — to ask a factual question — the domination of men gradually wither away? Will there be, as a key leap forward here to such a world, the demise of a gender-stratified and -oriented workforce? It is not unreasonable to hope that we will gain such things. Time alone will tell whether we actually will or not or whether we will go on with the same or similar destructive and unjust patterns of male domination. But there is by now an extensive awareness of how much harm male domination does: how many blighted lives, both female and male, result? But that is a lot about future possibilities; things are plainly hurting now and we would like to change things now and not simply wait for a perhaps long-coming and always chancy result. Can we, even in such circumstances, plausibly expect that things will end up as feminists and their allies wish, namely in a genuinely genderless society? It is possible to be pessimistic about that. Concerning our prospects here we have only models to go on. We have never had a genderless society any more than we have had a classless society. However, some places in the world are less sexist and less violent than others so that there is some room for a cautious optimism. Or at least we can reasonably so hope. But it still, in the best environment, hurts and hurts badly. It is not easy, or even desirable, just to wait for the productive forces to develop and for the experiment in living simply to go on. But it is also true that the mills grind slowly. The proper response to that, and to the sense of urgency related to it, seems to me to be one of uncompromising militancy and determination on the part of feminists and their allies coupled with a refusal on the part of women to make compromises. I say this with trepidation for it surely is not for me to tell women what to do. But what I believe, for what (if anything) it is worth, is that this activist militancy is necessary, together with a continued struggle for a more

adequate understanding of what the situation actually is, for what feasible possibilities there are and for good understanding of what emancipatory tactics will pay off. Theory without practice is empty, practice without theory is blind.

ENDNOTES

1. Linda Nicholson, *Gender and History* (New York: Columbia University Press, 1986); Nancy Fraser, *Unruly Practices: Power, Discourse and Gender in Contemporary Social Theory* (Minneapolis: University of Minnesota Press, 1989).
2. Nancy Hartsock, *Money, Sex and Power* (New York: Longman, 1983); Susan Moller Okin, *Justice, Gender and the Family*. (New York: Basic Books, 1989).
3. L. Nicholson, *op.cit.*; N. Fraser, *op.cit.*
4. John Scott, "The Men's Club: Rambo Ain't Heavy, He's my Brother", *Canadian Art*, Spring 1990, p. 20. See also in the same issue Gary Michael Dault, "Guns R Us: For Many Men, Actions Speak Louder than Words", pp. 17-18.
5. G.M. Dault, *op.cit.*
6. J. Scott, *op.cit.*, p. 20.
7. Annette Baier, *Postures of the Mind* (Minneapolis: University of Minnesota Press, 1985), pp. 74-90 and 207-208.
8. Susan Moller Okin, "Women and the Making of the Sentimental Family", *Philosophy and Public Affairs* Vol. 11, Winter 1982, pp. 65-88. See also her *Women in Western Political Thought* (Princeton, NJ: Princeton University Press, 1979).
9. Genevieve Lloyd, *The Man of Reason: 'Male' and 'Female' in Western Philosophy* (Minneapolis: University of Minnesota Press, 1984).
10. See Susan Moller Okin, "Philosopher Queens and Private Wives: Plato on Women and the Family", *Philosophy and Public Affairs* Vol. 6 (1979), pp. 345-69 and the reference in Note 9.
11. Kai Nielsen, "On Needing a Moral Theory: Rationality, Considered Judgments and the Grounding of Morality", *Metaphilosophy* Vol. 13 (1982), pp. 97-116.

MONIQUE FRIZE*

Women in Engineering†

Mon sujet va être très spécifique. Je veux traiter d'une des carrières où il y a moins de femmes, peut-être, que dans toutes les autres dans nos universités. Je dois vous dire que le 8 novembre, quand j'ai accepté cette position à l'Université du Nouveau-Brunswick, j'étais loin de croire que ma première journée au travail, le 11 décembre, consisterait à assister aux obsèques de onze jeunes femmes dans la Cathédrale de Montréal. Et ma deuxième fonction était de revenir très vite par avion, à deux heures, afin de donner un discours, à quatre heures trente, à une vigile pour ces jeunes femmes. Et dire que mon nouveau travail consistait à attirer des jeunes femmes en ingénierie, c'était presque une contradiction intolérable. J'ai mis du temps, quand même, à penser à ces événements et j'aurais voulu avoir plusieurs semaines pour me faire une idée plus précise de mes sentiments concernant tous ces événements. Malheureusement, les médias se sont occupés de moi tout de suite et déjà j'ai dû prendre position. J'ai donc pris une position très positive.

I decided therefore on that first very difficult day (11 December 1989) to take a very positive approach. If I was going to believe in my work, I had to believe that what had occurred at École Polytechnique was never going to happen again. Let me therefore discuss with you three things about engineering. First, three stereotypes that plague my profession; second, a few steps forward that have been taken; and third, some suggestions about how to prevent backslippage. It is difficult to talk concretely of slippage given that women constitute a mere 3% of engineers in Canada: we have barely begun!

The first stereotype is that engineering is a man's field. Is it really still true? Recently I was giving presentations in high schools to young students, males and females, in advanced classes and physics classes. I was telling them about careers in engineering and attempting to undo this very stereotype. I always try to bring with me some women engineering students or a woman engineer who is successful and loves what she is doing. I have done about thirty such

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† Présenté au colloque, «Les femmes et le haut savoir : Un pas en avant, deux pas en arrière?», University of Victoria, le 3 juin 1990.

presentations in the last three months, and seen about 1,500 students. Admissions of women students in Engineering at the University of New Brunswick have gone up 2% in those three months: we are now at 17% as of September 1990. So there is hope that this kind of positive action will help.

Nonetheless, a physics teacher who had come into one class, although it was not his class, got up at the end of the presentation of successful, live role models, and said, "Well in spite of all that you've said Dr. Frize, it's still a man's field". Imagine! I am thankful that it only happened once in thirty presentations, but I was a bit taken aback. He went on to add, "My daughter went to a conference last week and she was the only woman among forty-five men, so there you see, it's a man's world". Well, I won't bore you with the answers, but I did wink to the girls in the class while he was speaking and I am sure they understood my message. But still, that was very recent, and it is unfortunate, for this man is a teacher and he can negatively influence the young women whom we are trying to convince of the career possibilities in engineering.

Parents, teachers, counsellors, friends still steer women toward traditional occupations. Be a nurse, take care of people; be a teacher; be a secretary. It's just a part-time job until you get married and settle down to live happily ever after. The dream is still there in all the 'soaps' on T.V. and my job is to say: "You can do anything you want". I try to convince young women to believe in themselves. I say, "You're the only person who can stop yourself". Of course, that's not quite true. They do have all these other influences in their lives and what I'm trying to do now is to meet groups of teachers, parents and counsellors to give them the message that they must help. I can only cut one of the strings that may be preventing this young woman from going into a non-traditional career; all the rest is the responsibility of all of you, all of us, all our friends, and all our educators.

The second myth is that engineers wear hard hats and build bridges and roads. At least engineers are no longer presented as train drivers. Recently I received a letter from a young engineer from Western Canada. She wrote that when she was a high school student, she had a dry and boring notion of careers in the sciences. She had no idea what engineers did on a day-to-day basis. It took her six years of career exploration, research and family support to discover engineering; a field in which she is now happily employed as an environmental engineer. This woman wasted all those years searching for what she wanted to be. Our Vice-President, Academic, at the University of New Brunswick, Dr. Burridge, told me another story about a young woman who did four years of biology and only then discovered engineering; this year she graduated, a happy engineer, but after nine years of university. I think it's an intellectual crime not to give to our young people all the information possible about developing to their full potential.

Let me tell you what I do in schools. I tell young people: engineers work with people; engineers solve problems; engineers make decisions. They travel a lot. I tell them I am a mother, I have a nineteen year-old son, and I am a wife of twenty-two years. I show them that you can be married, you can have

children, you can have your own career. The women engineers that accompany me usually have happy stories. One of my favourite stories concerns a new engineer (all of eight months) with New Brunswick Power. Her employer gave her release time for three days and we visited some twelve schools in Bathurst, Campbellton and Dalhousie. We gave presentations in English and French, and it was clear she loved her work so much that she was able to spark the young people. They surrounded us after every meeting and were full of excitement. This woman engineer has just been promoted to a supervisory level position and she's going to work on a very interesting project, the thermal plant, in northern New Brunswick. She's building her first home with her husband this summer, and they're planning a family in about three years time. These are the kinds of stories I like to present in the schools. They are true stories and they work.

The third stereotype is that one has to be 'un génie' — a 'brain' — to be an engineer. I never use that word. I try to tell the students that a lot of very average boys become competent engineers and I would like our average girls to have the same opportunity.

In spite of these stereotypes, or perhaps because of them, steps forward have been taken. One step forward is the very Chair that I occupy at the University of New Brunswick. It was several years in the making and represents successful cooperation among the University, the industrial partner Northern Telecom, and NSERC. All three were motivated to do something in Canada to increase the number of women engineers. The Chair is to provide a role model for women considering engineering and that is why I do teaching and research as well as the promotion of women in engineering.

A second step forward is the Canada Scholarships, half of which must go to women. These scholarships have really helped in having more women in engineering because many of our very good women in engineering are Canada scholars. The only drawback so far is the grumbling one hears about the success rate of women in scholarship renewals. I am presently looking at this problem at my University. I volunteered to be a testing facility in order to examine each case. One such case concerns a brilliant student who had a baby, at age sixteen, when she was in grade 12. In spite of missing 40% of her school year, she ended up with an average of 87.8%. She obtained a Canada Scholarship. She entered her first year of engineering in September 1989. But it was the first time she had left home. She did not know how to take care of a baby. She was still a child herself. She had to take care of her apartment, her babysitter took a lot of time off, and the baby was very ill the first year. As a result she finished the year with a GPA of 2.4 and could lose her scholarship. Well, I intend to appeal because, when I look at her marks, she has A's, B's, and just one C, and this in spite of all her problems. She told me recently that she will certainly have better grades next year because her son is better, she knows how to take care of him and how to take care of the house, and she has a better babysitter this year. I really believe her. I think if I went to every individual case of non-renewal of the scholarship I would find many problems like this. Women have to have help and support, especially while they are a

minority in school, to be able to survive and do well. The options for that young mother were to she go on welfare and cost our country a lot of money or become a competent engineer, producing for her country. Which one is it going to be? Her family is poor and she is the oldest of several children. We have to create facilities to provide financial support for these women.

Another step forward is the fellowships that NSERC has created for women in scholarship and the summer assistantships. I think NSERC is really trying, but ten for the whole country each year is a mere beginning; we should have many more than that in the future.

As for steps back, statistics from the Canadian Engineering Manpower Board show that for engineers in the age group 25-39, only 23% of the women have reached supervisory levels after five years experience; 51% of the men are at that level. These are disturbing figures that will have to be examined.

How to prevent slippage? Well, we really have not made a great breakthrough yet. MIT and Caltech in the United States have reached levels of 33% women engineers in the last few years, and Quebec has the highest enrolments in Canada — over 20% — and now both UNB and Queen's University have 17% females in engineering. So I think things are improving. Out west the figures are a little lower but we can work on them too. I intend to network with women across Canada and with deans of engineering to try to build a recruitment program across Canada.

Slippage can be prevented by injecting constant energy into eliminating barriers to success, by developing and sustaining programs whose objectives are to attract and especially to retain women in engineering. Recruiting and training role models is very important. We almost had a disaster recently in my program where a young engineer who was very enthusiastic came to me and said, "I'm so alone. I want more women to be with me". She went by herself as a visitor to a very large school and was criticized for her presentation. It may have been a bit of a set up and certainly the effects could have been bad. I subsequently wrote to the school to clarify matters; I also provided some training as a role model, and now this young woman is doing successful presentations.

I now have a video of my school presentations and have shown it in P.E.I., Toronto and Vancouver. I am trying to share this information with other groups so that we can all make presentations in a more standardized fashion. Of course, in order to create a pool of future role models, women must be encouraged to enrol in graduate school, to specialize, to complete Masters and doctoral degrees, to take up academic careers in engineering so that we have a more gender-balanced faculty.

We also have to develop more materials specifically for girls, not just because the existing materials have few role models of women in the sciences, but also because the girls seem to make their decisions about engineering differently. Even if boys and girls react favourably to a presentation about engineering, the boy will make his application to engineering school right away. For the girls that is a much more difficult step. Most girls have to think about it and get approval from their friends and their parents. There was one

instance in Campbellton where the girl called the very next day and she is now in our engineering school. We need material that the girls can take home and read and think about. And even once they have taken the step to apply, they need continuing encouragement. At Queen's University, each woman admitted to the program is called personally to see if she needs information or has questions. It's very important to retain admissions, otherwise they can fall off before September.

Once the students are actually enrolled some need continuing encouragement. I have counselled more than a dozen young women this year. Some of them were 'A plus' students and suddenly they were totally de-motivated; all they needed was to talk to someone for about half an hour. I saw one of these young women two Saturdays in a row and now all of a sudden her marks, which were down at 'D', are back to 'A plus'. I call other women into my office, having looked at their marks, and I say, "Your marks are very poor, what's the matter?" Many of them say they are afraid to ask questions, they fear they'll be thought dumb. I say, "Well that is dumb! You're not dumb, but that is dumb. You must ask all the questions you want. I know you're visible. I know you're a minority, but you've got to do what's best for you." And now when I see them, they seem happier and their marks have improved. What a simple thing. It took me five minutes to solve the problem for two of them. Clearly there is a need for counselling on an individual and personal basis.

Finally, this country is going to be short of engineers in the year 2000. The country cannot afford not to interest women in this field.

Obviously there's no quick fix for this societal problem. Science culture is very much lacking in our country. We need more scientists and engineers and the only way we will get them is to change the books in the elementary schools, to give more science training to teachers, and, generally, have more programs on television. We have programs about doctors and lawyers but what about "Magnum, P. Eng.", or something like that? In the meantime, and considering the immensity of the task, more Chairs like the one I occupy should be established across Canada, with financial and moral support from the entire engineering community.

MARY JANE MOSSMAN*

A Paradigm Shift in Canadian Law Schools?†

INTRODUCTION

In preparing my remarks I have engaged in serious reflection on the title for this panel discussion: *Women in Scholarship: One Step Forward, Two Steps Back?*. There is no doubt, of course, that such a title suggests a pessimistic assessment indeed of women in academic life in Canadian universities. Coincidentally, for legal academics, the title of this panel is also the same as the title of a book recently published assessing women's gains under the *Charter of Rights and Freedoms*; despite a number of notable wins in the courts, there have also been difficult losses.

Yet, the title for this panel discussion is more than simply a statement of fact. The title also captures the profound heartache and fear now experienced by women in universities since, on the eve of the twentieth anniversary of the publication of the Royal Commission Report on the Status of Women, fourteen women aspiring to careers in engineering were killed because of a gunman's hatred for feminists.

While reflecting on the title, I was also reminded that a few weeks after the massacre, a stunning poster appeared in Toronto bearing the words "First Mourn, Then Work for Change". In thinking about issues of women and legal scholarship, I decided to explore the theme of the pattern of changes which have occurred for women in law. In doing so, I will be considering three things: first, the patterns of the past as they affect the present; second, the scope for change within the pattern of current tensions; and third, some suggestions for the future of changes in law.

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† Presented at the symposium, "Women in Scholarship: One Step Forward, Two Steps Back?", University of Victoria, 3 June 1990.

PATTERNS OF THE PAST

Before 1897, law (like other professions in Canada) was exclusively male. In 1897, however, Clara Brett Martin was admitted to practise law in Ontario, and, in the early decades of this century, other Canadian provinces admitted women as lawyers and as students in law faculties for the first time.

Despite their admission to the practice of law, however, very few women entered the legal profession for very many years in Canada. Moreover, from our perspective in the 1990s, women who become lawyers were generally admitted on male terms. That is, both law and the profession of law remained essentially unchanged; as a condition of entry to the profession, women were required to conform to the traditional culture of law, essentially one of maleness. This predicament is perhaps best illustrated by the response of Marguerite Ritchie, herself a very successful and distinguished member of the legal profession, in answering a survey question about discrimination against women lawyers. As she stated (about 1970):

> I have found that women are unwilling to admit discrimination, either because they are trying to conceal the fact from themselves or because...their chances of promotion depend absolutely upon their conformity to and acceptance of the existing patterns.[1]

CHANGING PATTERNS

From the beginning of the 1970s, however, new patterns have emerged for women in law. For example, there has been an exponential increase in the number of women entering law schools; in Quebec from the late 1970s, and in Ontario in the late 1980s, women comprise 50% of the entering and graduating classes. As a result, there has also been a dramatic increase in the number of women practising law; for example, 5% of the practising profession in 1977 were women, by comparison with 20% a decade later. About 1970, there were a number of appointments of the first women to faculties of law in Canadian universities, although it must be noted that the first woman was appointed to the Supreme Court of Canada before a woman became Dean of any Canadian law school. Moreover, the changes in these demographic patterns of the legal profession have resulted, in my view, in important changes in relation to law and its impact on our society. For example, women lawyers have been active in relation to the creation of the *Charter of Rights and Freedoms* and the interpretation of its protection for sex equality. Recent decisions in the Supreme Court of Canada concerning systemic discrimination, sexual harassment, benefits for pregnancy leave, and recognition of the battered wife syndrome all attest to the significance of women becoming lawyers in large numbers.

More fundamentally, however, the impact of these new patterns of women in law have resonated in the academic study of law. In this context, we have seen a fundamental questioning about the nature and role of law, the power of law and its limits, law's moral dimensions and its instrumentality, and most

importantly, male dominance in law. In thinking about these changes, I want to provide four brief examples about the impact of feminism on law in Canada. First, the impact of feminism in law is illustrated by our questioning of the neutrality and objectivity of law. We have begun to recognize law as a human construct, devised within a system of societal rules (and wholly constructed within a social, political, and economic context). In this context, we have begun to recognize the idea of law as a social phenomenon, with its own embedded and often invisible values and norms. A primary example is the feminist challenge to the idea of the 'reasonable' man in law. In recent years, we have begun to recognize the contingency of our idea of reasonableness, and that standards of behaviour for persons with relatively more power and resources in our society may need to be differently defined than standards of behaviour for persons with relatively lesser access to power and resources (including, of course, both women and other disadvantaged groups in Canadian society).

Second, the feminist challenge in law has been directed to questioning the centrality of law and legal discourse in problem-solving, the problem of using law to define what is at issue as well as to determine what evidence is relevant. Carol Smart has defined this focus on the centrality of law as the 'juridogenic' nature of law, "How law exercises power by resisting, disqualifying and de-emphasizing alternative accounts of reality". Obviously, a feminist challenge to the centrality of law restores the significance of women's accounts of their experiences, particularly for example in the context of debates about joint custody and the issue of consent in sexual assault.

Third, feminists question law's perspective as an abstract detached observer, separated from context and involvement with human lives. In the recent comments of Madame Justice Wilson on gender bias in the legal system, she examined the work of Carol Gilligan to find an explanation of the traditional features of the adversarial process: the reluctance of courts to go deeply into the circumstances of a case and the anxiety of judges to reduce it to its bare bones. As she said,

> We are all familiar with the witness on cross-examination who wants to explain his or her answer, who feels that a simple yes or no is not an adequate response, and who is frustrated and angry at being cut off with a half truth. It is so much easier to come up with a black and white answer if you are unencumbered by a broader context which might prompt you...to temper the cold light of reason with the warmer tints of imagination and sympathy.[2]

However, the most challenging part of feminism's questions for law schools focuses on the law schools themselves, and their uncritical stance toward themselves. My colleague at Queen's University, Sheila McIntyre, has best defined the nature of this part of the feminist challenge in her essay, "Prometheia Unbound":

> Feminist scholars apply their knowledge to change women's lives in the world. Accordingly, we expose and oppose sex discrimination

> wherever we are located. Male bias in pedagogy, in curriculum content, in staff and faculty hiring and in university administration are increasingly subject to challenges made possible and substantiated in large part by the scholarship produced by feminists within the university. And although feminist research is not widely credited within universities either as a legitimate discipline in its own right or as "scholarship", hostility to feminist scholarship is most undisguised where the critique focuses on the processes and consequences of sex discrimination within the university. If feminist scholarship in the form of theory is discounted, feminist scholarship embodied as praxis that is applied in the house of learning to secure concrete egalitarian change is shrilly denounced.[3]

Thus, we have new patterns in the law schools. Feminists are questioning the *status quo* of law and of law schools, as they are challenging fundamental ideas and traditional practices of law. Significantly, for women, for the first time in history, this questioning is occurring from the inside. Such a development poses an interesting question: what are the implications for change in law when there is a critical mass of women who challenge law as Insiders?

PROSPECTS FOR CHANGE

Within the academy, the idea of change attracts broadly-based curiosity and scholarly interest. In the humanities, for example, we are all familiar with the image of the Renaissance. (Even in this context, for those of us who have affection for the work of Joan Kelly, however, we must remember her assertion that there was no 'renaissance' for women, at least, not during the Renaissance.) In the context of the philosophy of science, many of us are familiar with the idea of paradigm shifts in the work of Thomas Kuhn. In the context of law, moreover, it has been asserted that the idea of paradigm shifts is particularly helpful to take into account the impact of the entry of previously excluded groups to the practice of law. In this context, we may well ask whether the law schools are currently experiencing a paradigm shift because of the entry of previously excluded groups, including women and also racial and ethnic minorities. Moreover, if the current situation is regarded as a paradigm shift, it is possible to regard the feminist challenge to law as a transformative process. In such a context, as well, the idea of backlash might be seen as evidence of entrenched opposition to change and a determined maintenance of the privileged *status quo*.

If the feminist challenge is seen in the context of a paradigm shift in law, the issues facing us can be seen as a need to identify the transformative project: for all of us, as women and men who are legal academics and who carry responsibility for educating women and men in law for the twenty-first century. In such a context, one might assert the necessity of law: language and behaviour respectful of women and men; and the elimination of the 'chilly climate', the 'poisoned environment', including sexual harassment in the law

schools. As well, a transformative project might require us to rethink the underlying assumptions in our definition of merit for hiring and promotion, as well as the substance of teaching materials and practices currently unreflective of white male bias in both law and lawyering.

More fundamentally, however, the transformative project would require us to reconceptualize law. In this respect, the current tensions in law schools (some more public than others) clearly reflect both the strength of the feminist challenge as well as the extent of entrenchment and resistance in the power of the *status quo*. In this context, the burning questions become those of defining roles for academic institutions and their community of legal scholars in shaping attitudes and defining the values of law and lawyers; in determining whether as individuals and as a collectivity we can recognize and accept that, if the Supreme Court of Canada can identify systemic discrimination as pervasive in all parts of our society, it is quite unlikely (indeed, almost impossible) that systemic discrimination stops at the door of the academy; and we can begin to question how to provide leadership in terms of affirming the values of tolerance and the responsible expression of ideas in ways which are not intimidating, not harassing, and not hostile.

These questions are about both pedagogy and scholarship which all of us who claim to be part of the Canadian academy must answer. In my view, however, there is also a need — at this moment in our history, in this critical moment of transition — for leadership in the legal academic community. On this basis, I call on university presidents, boards of governors, deans, and chairs of departments (overwhelmingly male persons in our academies at present) to demonstrate a commitment to the need for change, to support the transformative project of feminism, to acknowledge and to listen to the voices which signal a paradigm shift.

To our leaders, as to my feminist colleagues, I offer this challenge and this comfort. In the words of my favourite Judaic saying

> You are not required to complete the task;
> neither are you free to desist from it.

ENDNOTES

1. Quoted in Cameron Harvey, "Women in Law in Canada", *Manitoba Law Journal*, Vol. 4, 1970-71, p. 13. (Professor Harvey conducted a survey of women lawyers as the basis for his article, and quoted Ritchie's response to his survey offering the caution I have quoted here.)
2. Madame Justice Bertha Wilson, (Supreme Court of Canada), "Will Women Judges Really Make a Difference?" 4th Annual Barbara Betcherman Memorial Lecture, Osgoode Hall Law School, February 1990, p. 21.
3. Sheila McIntyre, "Promethea Unbound: A Feminist Perspective on Law in the University", *University of New Brunswick Law Journal* Vol. 38, 1989, p. 158.

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The Sandbox and the Tools†

Having taught engineering and engineers for the last twenty years, and much as a good deal of personal and professional friendship binds me to Monique Frize, I have a slightly less optimistic feeling than she does about what is ahead. This is not so much because of what she said [see pp. 31-35], but rather because I look at the whole situation.

In order not to be totally irrelevant for what we contemplate here as we look at women in scholarship, I would like to step back to a few definitions and general thoughts. Ruth Hubbard — her new book *The Politics of Women's Biology* is a must — provided a definition when speaking about scholarship and science that emphasizes the social nature of scholarship. She said scholarship is essentially socially sanctioned fact-making. There is in society a process by which experimentation, study and contemplation result in knowledge that society accepts, after certain processes of vetting, as fact. One of the most important things to realize is that it is a social process and much of that process of sanctioning the fact-makers is a process which has taken place within male society.

Who, for example, is entitled to make facts? Whose contemplation and whose work are then accepted as genuine facts? We know of course it is a limited group, a group that has privilege, status and reward, and a group to which increasingly the state and all its citizens give the wherewithal for appropriate fact-making. There is then an agreed practice which we call the scientific method; there is an agreed form of consensus which we call peer review. And the fact-makers in that process begin to address questions that, more frequently than not, are the very ones that those who provide the wherewithal, from the ancient church to the modern state, have an interest in seeing asked and answered.

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† Presented at the symposium, "Women in Scholarship: One Step Forward, Two Steps Back?", University of Victoria, 3 June 1990.

In a social context then, one has to ask whose questions are contemplated and for whose use are facts arrived at? One also has to ask, how does that process of fact-making advance? What happens when women attempt to acquire the tools and instrumentalities of fact-making and say, maybe we could make some facts too?

What happens then? Imagine a sandbox and there sit the boys with their tools and they say to the girls: "Maybe you could come and help me make some facts and if you are nice you can use some of my tools. And if you are really nice and I am in a real hurry and have to make a lot of facts for a lot of people, I can show you how to use those tools." That of course is a situation that we all recognize. The conflict arises when the girls say, "Really, you know, we want to use our own tools, maybe we want to make our own facts. Maybe we even want to have our own sandbox." What then? Of course some of the boys who are crude and a bit demented, like Marc Lépine and others, just throw the girls out and say "No, no, we don't want any girls around; the sandbox is getting crowded and, you know, some people may like your facts better than they like our facts and you might get some of the money for the new tools and we can't put up with that sort of thing." I think the challenge of feminist scholarship — and Mary Jane Mossman has described engineering schools as much as she described law schools [see pp. 37-41] — is in fact the struggle for the sandbox and the tools. That one can go around having a different process of fact-making, finding a different methodology, finding a different process of consensus and sanctioning, is indeed at the heart of feminist scholarship. It is asking not necessarily fellow scholars but possibly the recipients as well as the source of the factual knowledge one tries to accumulate: Does that make sense? Is that what you experience?

This is, of course, a most potent issue in the sciences, realizing that science in and of itself — in a way again like law — is an attempt to separate knowledge from experience. That works in some cases better than in others and in those fields in which science is ill-advised to rely totally on that part of knowledge that can be separated from experience, the challenge of different methodologies, the challenge of feminist methodology, becomes threatening. So what is before us, when we contemplate women in scholarship, is how to navigate around the spectrum that extends from teaching women the boys' tools so that they too can be part of that sandbox, to saying yes, perhaps the world is such a complex place that indeed we need not only different tools but also different fact-makers, different sandboxes. It may be necessary to admit that traditional fact-making is limited, inadequate, and may not even be good for the fact-makers.

It seems to me that this is where we now are. The question of women in scholarship has to be addressed over the entire spectrum that encompasses those who look for more women to be more or less street-proof to withstand the push and shove of the academy all the way to those who say the most important thing for us is to understand why it is that women and women's knowledge and women's scholarship have had so little part in the academy and in the fact-making. Thus we have to look at a spectrum of possible

research. I would therefore like to draw your attention first of all, to the constraints on women's scholarship that sit in the existing funding system. The questions that have to be asked in order to receive research support go through a process of elimination that in my opinion very often eliminates the most creative things. If there is anything that troubles me even more than discrimination in terms of people, it is the mortgage on the imagination that the granting system increasingly provides. That good, creative, imaginative thought — particularly among young scholars — should be stifled before it is even developed into questions through the put-down rationalization: who will ever fund this? Who will ever supervise a thesis like that? Who will ever give a scholarship? If there is anything we need to do, it is not to centralize funding and search for matching grants, but rather to have somewhere diversity, a seed bed for experimentation.

If I had money, one thing I would do is to have an annual conference on unfundable research. That would not entail those projects that were unsuccessful at NSERC this year. Rather it would be an invitation to imagine, to dream about the kinds of questions to which people retort after a good evening's discussion: "No way! Nobody will ever get any money for that." It may take a number of years, before people find their ideas sufficiently credible even to themselves, to be able to say, "Yes, I'll take that to next year's conference on unfundable research". Now this is more than a fanciful joke. I think it's really important to look at research in terms of fact-making and to see that it is not constrained to the obvious and that all the fact-making becomes merely an amplification of existing knowledge.

I would also like to see developed — a very simple piece of research — an index of well-being of women on campuses, like the indexes for restaurants. For the first time, in part due to the type of work that Monique Frize does, young women will have enough confidence to choose, not merely to be saying, "Thank God, I have a little niche here or a scholarship there", but rather to realize how important their presence is. They are the ones after all, who make the statistics that get their elders elected to The Royal Society of Canada and so they might as well make good statistics for hospitable universities. I see no reason not to develop out of those thirty parameters that the Ontario Confederation of University Faculty Associations (OCUFA) produced, a small set of indexes at the top of which I would place pay equity for senior women on the staff. It may be quite nice to be nice to young girls but there is a mortgage of thirty years or more of neglect which I see in my pension. I would add a number of indices such as: Are there people like Rose Sheinin in senior academic positions? Is there a harassment policy which is not just on paper? What about women's concerns in terms of the type of subject and the methods that are taught? Is there a real willingness to have interdisciplinary programs? Or are there, as I have found, appalling instances of young women petitioning <u>not</u> to have their extra-disciplinary courses — not just in women's studies but also in certain fields of the humanities or theological studies — recorded on their transcripts for fear that no one would hire a woman engineer who had taken two courses in pastoral care or women's studies. Is there a willingness to accept

an unusual-looking curriculum? Is there a willingness at the university to be interested in odd combinations of scholarship and not burden the students, as many of my women students have been, with a requirement of doing two Masters theses if they opted for interdisciplinary studies? So let us soon have a publicly available index on well-being — one that can be revised, just as restaurant indexes are — so that young women can choose.

Finally, I think we need a good deal more recognition that women contribute to scholarship whether they are on the professorial staff, on the support staff, or are secretaries or librarians. I have often been asked, especially in the past, what it is like being the only woman in the department, the only woman in the faculty and I always answer, "I am not. There are lots of women. There have always been lots of women." After all, we heard from Professor Nielsen how essential it is for the males to feel well serviced [see pp. 21-30]. So we have secretaries, lab technicians, librarians who all have a life of their own in scholarship as valid as ours. So, it is essential for us — especially for the senior women — to recognize this, to publish differently, to look at who contributed in a different manner, because if women want to be part of scholarship, other than being men in skirts, they are required both to be different and to do things differently. One of the different things that I find essential to do is to abandon the notion of rank and with it the thought that one becomes more clever as one attains the rank of full professor.

ACADÉMIE I

Académie des lettres et des sciences humaines

COLLOQUE :
LE DÉVELOPPEMENT DES RELATIONS
DU CANADA AVEC L'ASIE-PACIFIQUE

CLAUDE YVES CHARRON*

Évolution des échanges académiques entre le Canada et le Bassin du Pacifique : enjeux, contraintes et perspectives de développement†

Précisons, d'entrée de jeu, la problématique, la démarche méthodologique et les biais propres à la perspective de l'auteur déterminant l'orientation de cette enquête.

Cet essai s'articule à partir de la problématique suivante : quels sont les principaux enjeux, les contraintes et les perspectives de développement de l'évolution de nos échanges académiques avec la région Asie-Pacifique?

Les traits distinctifs relatifs aux types d'enjeux, de contraintes et de scénarios prévisionnels proviennent de trois types de sources :

a) une série d'entrevues auprès d'un échantillon restreint d'intervenants privilégiés : l'AUCC, le BCEI, les divisions académiques et politiques du ministère des Affaires extérieures et du Commerce extérieur Canada, les responsables de l'Éducation des ambassades de Chine et du Japon, le MRI, et différents responsables de la coopération au sein d'universités canadiennes, les représentants d'organismes impliqués dans des programmes de formation ou de recherche avec la région, tels l'ACDI, le CRDI et la Fondation Asie-Pacifique du Canada;

b) les rapports publiés ou diffusés par ces organismes;

c) un stage d'observation participante de plus de deux ans de juillet 1987 au mois d'août 1989, alors que l'auteur agissait comme sinologue en résidence et Premier secrétaire (aux affaires scientifiques et culturelles) de l'ambassade du Canada à Beijing, stage d'observation participante lui

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offrant une perspective alliant à la fois celle d'un gestionnaire de programme en relations avec les différentes institutions canadiennes et chinoises en cause, tant en sciences pures qu'en sciences humaines, ainsi qu'une série d'observations sur le terrain lors de problèmes de négociations et/ou d'implantation de nouveaux programmes.

Il dut aussi agir comme l'un des responsables de l'évacuation de quelque 550 professeurs et étudiants canadiens de Pékin en juin 1990 et vit plusieurs de ses programmes «temporairement» remis en cause.

Ce type d'expérience sur le terrain introduit sans aucun doute un biais certain dans son analyse de la situation, surtout en ce qui concerne l'élaboration de scénarios prévisionnels, une prise en compte de la spécificité du contexte socio-politique des différents pays de la région, et un respect considérable pour celles et pour ceux qui ont choisi de tenter de poursuivre ce type de travail de coopération, dans une perspective dépassant les saisons immédiates, et conservant une perspective historique et un horizon à moyen et à long terme.

L'horizon qui sera utilisé dans cet essai, pour la discussion des enjeux, contraintes et perspectives de développement, le sera à moyen terme, d'ici 10 ans, soit l'an 2 000.

De façon complémentaire à cet horizon diachronique, l'un de nos cadres de références privilégié sera précisément la nouvelle stratégie d'intervention du gouvernement canadien dans la région, dite «Pacifique 2000».[1]

Encore relativement peu connue, et dans une phase d'implantation depuis quelques mois à peine, cette stratégie représente un axe d'intervention privilégié en termes de «policies» our nos relations tant bilatérales que multilatérales dans la région. Nous tenterons de dégager certaines des incidences de cette nouvelle stratégie par rapport à la dynamique des échanges académiques. Mais puisqu'elle en est seulement à ses tout débuts et que l'objectif majeur de cette stratégie est d'abord et avant tout essentiellement d'ordre commercial, il est très difficile d'en évaluer les retombées spécifiques du côté académique.

Dernière précision d'ordre méthodologique : puisqu'il n'y a peu ou pas d'institution canadienne ayant une vue d'ensemble de tous nos échanges académiques avec les pays de la région Asie-Pacifique, cette enquête sectorielle conduite en moins d'un mois ne peut évidemment pas prétendre à l'exhaustivité, fonctionnera en termes d'échantillons, tentant de dégager quelques tendances centrales et quelques faits poteurs d'avenir. Il va de soi que [illegible]reur d'interprétation ne relève que de l'auteur, et n'implique en au[illegible]çon les répondants qui ont bien voulu nous accorder des entrevues (de type semi-dirigé d'en moyenne trois heures chacune).

Telles sont les limites de validité de cet essai : une tentative, à partir de ces trois types de sources, d'identifier quelques-uns des traits distinctifs de la dynamique propre à l'évolution de nos échanges académiques avec les pays de la région.

Observons donc quelques-uns de ces traits distinctifs en fonction d'une approche en deux temps : d'abord les enjeux et les contraintes, puis, les

perspectives de développement en fonction de quelques scénarios prévisionnels.

LES ENJEUX ET LES CONTRAINTES

Certaines «énigmes», selon la terminologue de Kuhn, émergent des entrevues que nous avons conduites auprès des différents intervenants impliqués dans cette problématique :

a) Pourquoi y a-t-il autant d'étudiants asiatiques poursuivant des études graduées au Canada, parlant déjà l'anglais ou le français, mais si peu d'étudiants canadiens étudiant en Asie?

b) Qu'en est-il de la capacité d'absorption des universités canadiennes pour ces cohortes d'étudiants provenant de Malaisie, de Hong-Kong ou de Chine : avons-nous atteint un certain seuil, un certain quota au-delà duquel il serait délicat d'aller, au détriment d'étudiants venant d'autres régions du monde?

c) Si le développement des relations commerciales et politiques avec ce «nouveau centre du monde» est prioritaire pour le Canada, comment expliquer qu'il y ait aussi peu de programmes de recherche et de formation au sein des universités canadiennes? Quelle est la volonté politique des institutions canadiennes (académiques et gouvernementales) en ce sens?

d) Dans combien d'universités asiatiques offre-t-on des cours sur le Canada? Y conduit-on des recherches avec publications sérieuses à l'appui? Quelle est la présence du Canada dans l'enseignement et la recherche au sein des institutions asiatiques?

e) Quels sont les liens entre les stratégies politiques (et commerciales) du gouvernement canadien dans la région et les programmes de formation d'une relève à intervenir à titre d'interlocuteurs et d'interlocutrices avec les intervenants asiatiques?

f) Pourquoi n'avons nous presque aucun étudiant japonais poursuivant ses études de doctorat dans un université canadienne? Ne sommes-nous bons à offir que des cours d'anglais langue seconde à la cohorte d'étudiants japonais, ou alors des programmes de formation graduée aux étudiants d'autres régions qui viendraient au Canada à cause des programmes d'aide payant en majeure partie leur scolarité?

g) Qu'adviendra-t-il de nos échanges académiques avec la Chine, alors que la Commission d'État à l'Éducation vient de décider de ne plus envoyer aucun étudiant chinois pour des études de maîtrise ou de doctorat au Canada?

h) La stratégie de «Pacifique 2000» vise quels types de public cible prioritaires? Permettra-t-elle de consolider les programmes d'études asiatiques au sein des universités canadiennes?

i) Quels sont les scénarios dominants de nos échanges avec cette région d'ici 10 ans? Allons-nous surtout vers une fermeture, non seulement à cause de la situtation actuelle en Chine mais aussi en fonction des capacités

d'absorption d'étudiants asiatiques au sein de nos universités canadiennes, d'une saturation des places disponibles, des limites inhérentes à nos capacités d'accueil au sein de nos 54 universités canadiennes?

Voilà quelques énigmes parmi d'autres. Afin de les situer dans un cadre de référence permettant d'interpréter les contraintes qui déterminent la dynamique en présence, et afin de tenter de construire une base permettant d'élaborer certaines types de scénarios prévisionnels pour l'évolution de nos échanges académiques avec cette région, observons quelques-uns des traits distinctifs propres à la conjoncture actuelle, une conjoncture où certaines des contraintes de base résident du côté de notre propre environnement canadien, et un système éducatif décentralisé, ce qui implique des variations considérables de l'ouest à l'est du Canada concernant nos échanges avec l'Asie-Pacifique ou l'enseignement des langues asiatiques aux niveaux primaire, secondaire, collégial et universitaire.

TROIS NIVEAUX D'ANALYSE

Nous distinguerons d'entrée de jeu trois niveaux d'analyse, les niveaux «micro», «méso» et macrosociologiques avec, pour chacun de ces niveaux, certains types d'invariants, de tendances lourdes et de faits porteurs d'avenir. Dans le cadre restreint de cet essai, le niveau «micro» sera relié aux flots d'étudiants sur une base individuelle, le niveau «méso» aux échanges inter-institutionnels et enfin, le niveau «macro» aux politiques en matières d'éducation entre le Canada et d'autres pays, d'autres régions et, dans le cas qui nous intéresse, en relation avec la région du Bassin du Pacifique.

Le niveau microsociologique : les flots d'étudiants et la contrainte du «juste équilibre»

Lors de certaines de nos entrevues auprès des Bureaux de Coopération internationale d'universités, certains représentants mettaient de l'avant un certain type de contrainte :

> peut-être avons-nous maintenant trop ou suffisamment d'étudiants en provenance d'Asie, et puisque nos capacités d'accueil surtout au sein des programmes gradués de nos universités sont limitées, peut-être en sommes-nous arrivés à un moment délicat où, lors du processus de sélection, l'on doive préserver un «juste équilibre entre les régions d'origine de nos étudiants étrangers».[2]

Voilà sans doute un type de contrainte, résultant de l'évolution récente de nos échanges académiques, qu'il nous faut tenter de mettre en contexte avant de tenter de l'interpréter.

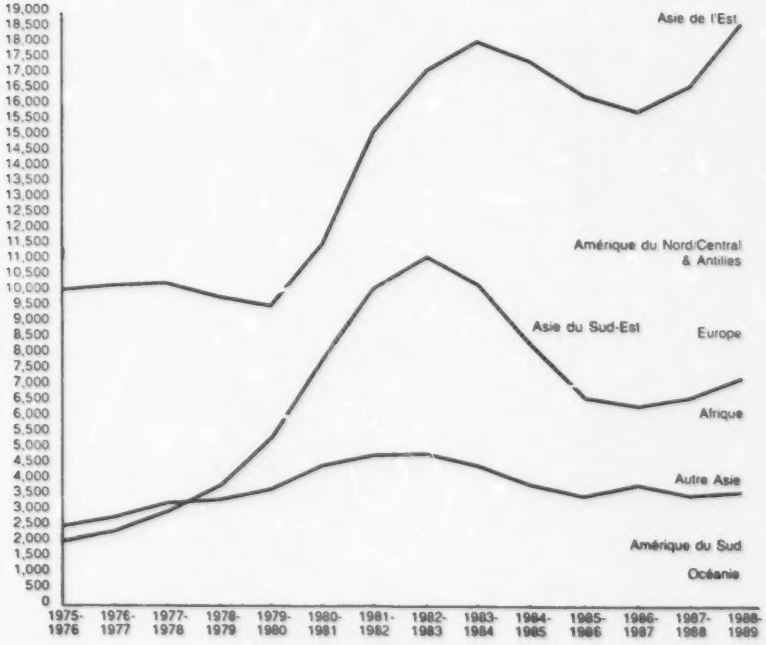
En 1988-1989, le Canada accueillait plus de 58 000 étudiants étrangers, comparativement à 42 436 en 1975-1976. Cet accroissement témoigne d'un mouvement qui reflète la multiplication des étudiants de toutes les régions de monde, mais certains traits distinctifs mis de l'avant par le Bureau Canadien

de l'Éducation Internationale (BCEI) méritent d'être soulignés : «les plus grandes augmentations proportionnelles ont été de l'Océanie, de l'Est asiatique et de l'Europe, mais cette année on a vu la stabilisation des déclins enregistrés depuis plusieurs années en ce qui concerne même l'Afrique et l'Amérique du Sud».[3]

Cette impression dominante selon laquelle nous avons, au sein de nos institutions, beaucoup d'étudiants asiatiques, en comparaison avec des étudiants provenant d'autres régions est donc pertinente.

Mais observons brièvement l'évolution historique récente de ces différentes vagues d'étudiants étrangers, des quatre coins du monde, à la figure 1, recadrant ainsi cette tendance lourde en comparaison avec les tendances des clientèles des autres régions.

Figure 1. Inscriptions totales des étudiants étrangers au Canada, selon la région d'origine, 1975-1976 à 1988-1989.



Source : BCEI, 1989 : 12

Tableau 1 : Inscriptions totales des étudiants étrangers au Canada, selon la région d'origine, 1975-76 à 1988-89

	Afrique	Asie du Sud-Est	Asie de l'est	Autre Asie	Europe	Amér. du Nord/Centrale et les Antilles	Amérique du Sud	Océanie	Sans pays	Pays non déclaré	Total
% croissance 1987-88 à 1988-89	6,4	6,6	12,2	4,0	11,3	5,6	4,2	13,0	7,4	NA	6,6
% du total 1988-89	10,1	12,6	32,2	6,4	14,5	18,5	2,5	1,4	1,3	0,5	100,0
1988-89	5 932	7 399	18 821	3 734	8 459	10 836	1 461	817	742	270	58 485
1987-88	5 575	6 796	16 775	3 591	7 599	10 239	1 421	723	691	443	53 853
1986-87	5 903	6 526	15 879	3 906	7 240	9 886	1 514	645	553	169	52 233
1985-86	6 233	6 863	16 390	3 584	7 092	10 240	1 650	649	504	610	53 824
1984-85	6 485	8 447	17 543	3 963	7 070	10 788	2 041	600	512	466	57 915
1983-84	6 902	10 324	18 246	4 517	7 505	11 701	2 462	588	629	572	63 545
1982-83	6 567	11 187	17 237	4 983	7 940	12 211	2 804	601	662	607	64 799
1981-82	5 398	10 194	15 277	4 953	7 508	11 869	2 705	654	639	891	59 868
1980-81	4 687	7 885	11 554	4 561	6 260	10 599	2 365	542	357	773	49 563
1979-80	4 409	5 498	9 530	3 841	6 147	9 934	2 077	554	325	1 494	43 803
1978-79	4 014	3 940	9 868	3 448	6 233	10 049	2 172	513	424	1 734	42 395
1977-78	3 545	3 076	10 309	3 332	6 216	10 832	2 362	413	504	1 651	42 240
1976-77	2 973	2 437	10 248	2 636	5 709	11 147	2 142	442	607	4 183	42 724
1975-76	2 681	2 052	10 006	2 522	4 138	11 281	2 127	382	715	6 533	42 436

Note : Voir le tableau en Annexe, pour la définition de l'Asie, L'Asie de l'est et l'Asie du Sud-Est.

Tableau 2 : Inscriptions totales aux écoles canadiennes primaires et secondaires des étudiants étrangers des dix premiers pays d'origine, années choisies, 1975-76 à 1988-89

Pays	1975-76	1980-81	1985-86	1986-87	1987-88	1988-89	% croissance 1987-88 à 1988-89
1 Hong-Kong	3 292	3 623	3 404	3 389	3 696	3 721	4,6
2 États-Unis	887	1 549	2 476	2 449	2 566	2 823	10,0
3 Japon	41	386	894	963	1 303	1 832	40,6
4 Royaume-Uni	306	472	662	779	720	841	16,8
5 Taiwan	19	97	178	277	441	771	74,8
6 Allemagne (Rép. féd.)	54	350	511	525	628	674	7,3
7 Mexique	263	266	304	327	380	428	12,6
8 Chine	48	62	141	211	222	416	87,4
9 France	62	182	270	277	312	348	11,5
10 Malaisie	204	2406	665	486	352	331	-6,0
				Total 10 premiers pays	10 822	12 185	12,6
				Total ét. étr.	16 753	18 514	10,5
				10 premiers en % des ét. étr.	64,6	65,8	—

Source : BCEI, 1989 : 13

D'une façon générale, les inscriptions ont atteint un niveau de pointe au début des années 1980, suivi d'un déclin. Un trait distinctif essentiel, toutefois, concerne l'importance relative des inscriptions en provenance de l'Asie de l'Est qui domine de loin les mouvements d'étudiants en provenance d'Europe et d'Afrique.

Les statistiques compilées par le BCEI et illustrées dans le tableau 1 démontrent avec précision les distributions respectives de ces différentes clientèles, selon leur région d'origine.

L'analyse de ces statistiques pour les trois régions de l'Asie de l'est, du Sud-Est et «autre Asie» exige une délimitation précise des différents pays d'origine de cette clientèle étudiante. L'on pourra consulter en annexe la légende explicative des divisions régionales utilisées dans la figure 1 et le tableau 1. Cette précision est importante, dans la mesure où le BCEI a, de façon étonnante, choisi de situer la Chine populaire au sein de la région Asie du Sud-Est, plutôt qu'au sein du sous-ensemble géographique auquel elle appartient, en l'occurence l'Asie de l'Est.

Afin de compléter ce travail de mise en contexte, il est important d'observer la distribution des ces mouvements d'étudiants selon leur niveau de formation du moins pour les 10 pays les plus importants. Ainsi le tableau 2 illustre cette distribution aux niveaux primaire et secondaire, le tableau 3 au niveau collégial et le tableau 4, au niveau universitaire.

Hong-Kong demeure le principal pays d'origine des étudiants étrangers venant au Canada, et il est probable que cette tendance se maintienne, avec les incertitudes reliées à l'horizon 1997.

Les fluctuations concernant d'autres pays de la région asiatique, dont la Malaisie et les Philippines, sont en relation avec les politiques de priorité de certains programmes des Affaires extérieures avec les différents pays de l'ANASE.

Certaines énigmes apparaissent également : il est étonnant de constater que, si les inscriptions en provenance du Japon occupent la troisième et la quatrième position respectivement du primaire au collégial, elles sont loin derrière au niveau universitaire. Il semble que notre système de formation soit pertinent pour cette clientèle, surtout pour les programmes d'anglais langue seconde, mais pas pour nous études universitaires. N'est-ce pas là une tendance étonnante? Comment faudrait-il l'expliquer?

Une autre énigme concerne l'importance relative des inscriptions au niveau universitaire, avec Hong-Kong, la Chine, la Malaisie et Singapour occupant les cinq premiers rangs, à l'exception d'un seul pays, les États-Unis, représente une autre région. L'on est loin des tendances antérieures, les inscriptions en provenance de France et du Royaume-Uni se retrouvant cette fois en sixième et en huitième position.

L'image initiale, dégagée lors des entrevues, des minorités visibles asiatiques dominant la scène universitaire, est donc fondée.

Tableau 3 : Inscriptions totales aux collèges canadiens des étudiants étrangers provenant des dix premiers pays d'origine, années choisies, 1975-76 à 1988-89

Pays	1975-76	1980-81	1985-86	1986-87	1987-88	1988-89	% croissance 1987-88 à 1988-89
1 Philippines	20	42	866	1 372	2 177	2 719	24,9
2 Hong-Kong	1 818	779	1 309	1 167	1 248	1 247	-0,1
3 États-Unis	1 749	1 095	890	851	1 017	862	-15,2
4 Japon	80	219	252	225	420	672	60,0
5 Chine (Rép. pop.)	85	66	157	190	207	380	83,6
6 Royaume-Uni	227	149	345	327	368	254	-31,0
7 Trinité-et-Tobago	403	241	291	259	275	251	-8,7
8 Liban	0	2	541	452	315	210	-33,3
9 Mexique	138	163	140	131	170	205	20,6
10 Malaisie	285	280	306	259	189	190	0,5
			Total 10 premiers pays		**6 386**	**6 990**	**9,5**
			Total ét. étr.		**9 961**	**10 534**	**5,5**
			10 premiers en % des ét. étr.		**64,0**	**66,4**	—

Tableau 4 : Inscriptions totales aux universités canadiennes des étudiants étrangers provenant des dix premiers pays d'origine, années choisies, 1975-76 à 1988-89

Pays	1975-76	1980-81	1985-86	1986-87	1987-88	1988-89	% croissance 1987-88 à 1988-89
1 Hong-Kong	3 860	4 993	7 196	6 136	5 370	5 084	-5,3
2 États-Unis	4 046	2 987	2 219	2 317	2 330	2 608	11,9
3 Chine (Rép. pop.)	213	187	865	1 233	1 701	2 456	44,4
4 Malaisie	441	2 956	1 977	1 326	1 116	1 205	8,0
5 Singapour	132	613	1 009	1 023	982	1 007	2,5
6 France	262	396	453	509	645	831	28,8
7 Inde	527	662	772	764	745	824	10,6
8 Royaume-Uni	1 724	1 670	1 039	890	755	813	7,7
9 Kenya	106	151	396	413	405	426	5,2
10 Trinité-et-Tobago	393	567	703	639	543	425	-21,7
			Total 10 premiers pays		**14 862**	**15 979**	**7,4**
			Total ét. étr.		**23 336**	**25 221**	**8,1**
			10 premiers en % des ét. étr.		**62,5**	**62,2**	—

Source : BCEI, 1989 : 14

Une analyse en profondeur de ces mouvements d'étudiants se doit de discuter certains enjeux, dont celui de la provenance, de l'équilibre géographique ou, pour reprendre le concept mis de l'avant par le BCEI en 1981, le «juste équilibre».[4]

Mais cet équilibre ne devrait pas être défini uniquement en terme régional, mais aussi en relation avec la proportion d'étudiants des pays en voie de développement ou des pays nouvellement industrialisés, lesquels ont plus que d'autres peut-être besoin de l'aide du Canada pour le développement de leurs ressources humaines, composante essentielle de toute stratégie de coopération et de développement.

On constate ici l'interdépendance étroite des différents niveaux, du «micro» au «macro», des mouvements d'individus aux politiques de coopération inter-institutionnelle et nationale, avec de grandes agences, allant de l'ACDI ou du CRDI à la Fondation Asie-Pacifique ou à la Japan Foundation. Et cette discussion du concept de «juste équilibre» ne peut se limiter ni se résoudre au niveau microsociologique, puisqu'elle implique les preneurs de décision au niveau institutionnel et au niveau national.

Mais, chose certaine, à ce premier niveau, il est impossible d'accepter comme un choix rationnel l'hypothèse voulant qu'il faille limiter l'accès aux admissions d'étudiants de la région asiatique au sein de nos universités canadiennes, puisqu'une bonne partie de cette cohorte d'étudiants se retrouvent aux différents cycles d'études et non seulement au niveau universitaire.

Après cette première contextualisation au niveau des mouvements d'étudiants, passons maintenant aux tendances lourdes déterminant la dynamique en présence aux autres niveaux.

Le niveau inter-institutionnel : de la capacité d'absorption à l'internationalisation

Presque la totalité des institutions d'enseignement supérieur canadiennes ont conclu des protocoles d'échange avec des institutions du Bassin du Pacifique. Il s'agit là d'un phénomène récent, depuis les quinze dernières années, du moins au niveau de la majorité des institutions.

Cette tendance centrale est surtout due, pour les relations avec les pays en voie de développement et les pays nouvellement industrialisés de la région, aux programmes d'aide de l'ACDI[7] (tant du côté de l'inter-institutionnel que du bilatéral) et du CRDI.[6]

Plus récemment encore, le Canada et l'AUCC devenaient le siège du secrétariat de grands programmes de la Banque Mondiale pour des projets dans la région (en particulier avec le programme des universités provinciales en Chine).[7]

Ces échanges inter-institutionnels se sont donc développés via différents programmes, au multilatéral, au bilatéral, mais aussi au niveau provincial. Mentionnons, à titre d'exemple, le «Ontario-Jiangsu Educational Exchange Program».[8]

La stratégie de l'ACDI privilégiant le développement des ressources humaines en Chine, depuis 1983, a constitué un point tournant dans le développement de nos relations avec ce pays et avec la région. De grands programmes dont le «Canada-China Management Education Program», et le programme de jumelages inter-universitaires ont permis de développer une expertise nouvelle au sein d'agences canadiennes. Aujourd'hui, l'AUCC, la Fédération des doyens de science de la gestion, l'ACCC, la Fédération des Municipalités et le «Conference Board of Canada» administrant des programmes de l'ACDI, en moyenne, de $20 millions dans la région, sans parler d'agences comme l'EUMC et le BCEI qui s'occupent de certains chercheurs et étudiants chinois venant au Canada au sein de ces programmes.

Lors de notre dernier mandat comme responsable des échanges académiques avec la Chine à l'ambassade du Canada à Beijing, de 1987 à 1989, il était impossible de voir passer une semaine sans recevoir ou envoyer des délégations, de part et d'autre de la grande muraille.

Et l'orientation même de cette stratégie de développement des ressources humaines de l'ACDI était souvent citée en exemple aux gestionnaires de programmes avec d'autres pays.

Il importe également de souligner la présence et la performance exceptionnelles du CRDI dans la région, rayonnant à partir de son Centre régional à Singapour. Un trait distinctif important des programmes de recherche du CRDI : leurs objectifs de base concernent la consolidation des institutions de recherche au sein même des pays en développement de la région, la conduite de projets de recherche appliquée avec des retombées dans leur environnement immédiat, et la diffusion des résultats de la recherche auprès des preneurs de décision des appareils en place.

La multiplicité de ces échanges est due en bonne partie aux initiatives des Centres d'études asiatiques des universités canadiennes, suivies d'une ouverture et d'un intérêt dans d'autres secteurs institutionnels.

Certains intervenants interrogés, lors de la préparation de cette conférence, soulevèrent toutefois une contrainte particulière : «sans les budgets de grands organismes subventionneurs tels l'ACDI, plusieurs de ces programmes n'auraient pas vu le jour; sans un support financier continu, plusieurs de ces projets risquent de mourir de leur belle mort, à la fin du cycle du projet en cause». Certains bureaux de coopération internationale d'université préfèrent une stratégie étapiste («nous ne signerons un protocole que lorsque nous aurons les budgets pour mener à terme, à la satisfaction de l'ensemble des parties en présence, les objectifs des projets»), alors que d'autres continuent à aligner une liste de protocoles ouverts, tout azimut, indépendemment des budgets disponibles (stratégie désignée, par certains, des protocoles de type «éléphants blancs»).[9]

Dans l'ensemble, certaines des contraintes en présence relèvent moins de l'absence de programmes ou d'expertise que du côté de l'absence de concertation, de l'absence d'une approche unifiée au niveau national pan-canadien ou d'une instance analogue au British Council. Il est encore très fréquent, dans nos ambassades à l'étranger, que les responsables des programmes de l'ACDI

ne connaissent même pas les programmes du CRDI dans des secteurs analogues et parfois avec les mêmes partenaires canadiens ou asiatiques. Et pourtant, ces deux organismes n'ont-ils pas des objectifs similaires?

Certaines agences canadiennes, pour reprendre cette terminologie de l'ACDI, sont plus souvent en compétition les unes avec les autres (par exemple l'AUCC, l'EUMC, le BCEI) qu'en concertation pour certains projets de l'ACDI ou de d'autres instances. Certains diront : «c'est là de la petitesse, et un manque d'expertise au niveau international. C'est oublier que nos véritables compétiteurs internationaux eux, ont davantage de concertation».[10]

Cette absence de concertation, cette multiplicité d'intervenants, cette multitude de délégations d'une université à l'autre, d'une province à l'autre, d'un organisme fédéral à l'autre constituent la trame de fonds du stéréotype voulant que nous ayons maintenant trop d'étudiants asiatiques au sein de nos institutions, et de son corrolaire : notre capacité d'absorption a atteint une certaine limite.

D'où l'émergeance d'un débat oscillant entre deux grandes tendances : à un extrême du continuum l'on défend une logique d'argumentation en termes de limites de la capacité d'absorption et à l'autre, en termes d'internationalisation.

À la consultation de juin 1989 sur les étudiants étrangers, organisée par le Secrétariat d'État, la réponse à la question «quelle est votre capacité d'absorption» est zéro, compte tenu du sous-financement chronique et de la détérioration de l'infrastructure de l'éducation universitaire au Canada.

À l'autre extrême du continuum, on retrouve les tenants d'une perspective inverse : non plus la fermeture mais l'ouverture, l'internationalisation. La plupart de ces intervenants se situent à la suite des travaux de séminaire de novembre 1988 de l'Organisation de la coopération et du développement économiques (OCDE) à Hiroshima :

> L'internationalisation de l'éducation supérieure suppose un système d'éducation supérieure plus sophistiqué, enrichi et pouvant accueillir des étudiants de tous les millieux culturels et de tous les pays. Il s'agit essentiellement de mettre au point des programmes de nature internationale et multiculturelle, propres à offrir à tous les étudiants les expériences et la formation nécessaires pour les préparer à vivre dans un monde où ne cessent de se multiplier les échanges internationaux.

Et pourtant, malgré cet appel à l'ouverture et à l'internationalisation, certains parmi nos plus grands organismes canadiens, dont le CRSH, aboliront certains de leurs programmes de coopération bilatérale avec la Chine, le Japon, la France et la Hongrie.[11]

Un tel mouvement de recul rend bien compte de tendances contradictoires entre les tenants de la fermeture et ceux de l'ouverture, tendances contradictoires s'inscrivant au sein d'une dynamique relativement récente d'ouverture vers l'international, surtout en relation avec la région du Pacifique.

Et l'on retrouve des tenants de ces deux tendances au sein de chacune de nos institutions.

Il a été dit dans le *Rapport de la Commission royale d'enquête sur l'union économique et les perspectives de développement du Canada* et dans le rapport de Paquet, *Postsecondary Education: An Enterprise Less than Optimally Managed?*, que les collèges et les universités du Canada manquent de souplesse et qu'ils sont lents à s'adapter aux besoins changeants.[14] Nul doute que la prochaine phase de développement de nos échanges académiques avec la région du Pacifique présentera de nouveaux défis à nos institutions, défis auxquels il nous faudra répondre au risque de voir la formation internationale de nos propres étudiants d'origine canadienne se replier dans les ornières de l'ethnocentrisme.

Et l'un des indices les plus révélateurs des risques de cet ethnocentrisme de demain, suite à cette tendance à la fermeture : combien de nos professeurs et de nos étudiants de collèges et d'universités canadiennes peuvent parler la langue de notre deuxième partenaire commercial, et centre de gravité de la région du Pacifique : le Japon? Combien?

Le niveau macrosociologique : la stratégie «Pacifique 2000»

La stratégie «Pacifique 2000» fut annoncée à l'automne 1989 par le premier ministre du Canada. Elle s'intègre dans un ensemble de «policies» regroupées sous le thème de «Horizon le monde», totalisant la somme de 93,6 $ millions, comportant trois volets : l'un axé vers les États-Unis, dans le contexte du libre-échange, l'autre vers l'Europe 1992, visant à permettre aux Canadiens de se préparer à l'intégration du marché européen, et enfin «Pacifique 2000», orientée vers le Bassin du Pacifique.

Définie comme un ensemble d'initiatives sur une période de cinq ans, cette stratégie s'articule par rapport à quatre grands domaines, pour garantir que le Canada renforce son rôle dans la région la plus dynamique du monde :

a) Une stratégie commerciale
b) Un fonds de coopération scientifique et technologique avec le Japon
c) Un fonds Pacifique 2000 pour l'apprentissage des langues et des réalités asiatiques
d) Un fonds pour les projets Pacifique 2000.

Le concepteur et maître d'œuvre de cette stratégie n'est nul autre que le ministère des Affaires extérieures et du Commerce extérieur Canada. Observons brièvement les principaux traits distinctifs et types d'activités prévues au sein de ces quatre domaines, et la place dévolue à l'éducation et à la formation.

a) **Une stratégie commerciale** ***(14 $ millions)***

Le public cible privilégié : le milieu des affaires. Les activités se distribuent ainsi :

i) **La stratégie nationale du commerce (SNC) :** identification de débouchés spécifiques; campagnes de promotion pour saisir les nouveaux débouchés; collecte de renseignements techniques et commerciaux sur les obstacles aux importations.

ii) **Pénétration de secteurs clés des marchés :** participation à des conférences et à des expositions spécialisées, programme d'accueil de journalistes étrangers et de missions de journalistes canadiens.

iii) **Présence accrue :** petits bureaux satellites au Japon, en Chine et en Corée.

iv) **Alliances en matières d'investissement :** programme d'information pour expliquer aux investisseurs étrangers les avantages de l'ALE; création de banques de données directement consultables pour favoriser les transferts de technologie et l'investissement.

v) **Groupes bilatéraux de gens d'affaires :** appui pour mobiliser et sensibiliser les exportateurs, établir des bureaux à l'étranger et élargir les relations avec des groupes homologues.

b) Fonds de coopération scientifique et technologique avec le Japon *(24,1 $ millions)*

Pour renforcer la base scientifique et technologique du Canada par un resserrement des liens bilatéraux en matière de S&T, notamment avec les instituts de recherche et les organismes privés du Japon, afin de permettre la mise au point conjointe de technologies et la formation d'alliances stratégiques dans d'importants secteurs de première importance nationale.

Le Fonds encouragera des activités se distribuant ainsi : échanges de longue durée (de 6 à 18 mois) et de courte durée (de 2 à 4 semaines), des projets bilatéraux, des ateliers conjoints, et des programmes de formation linguistique pour gens d'affaires.

c) Fonds Pacifique 2000 pour l'apprentissage des langues et des réalités asiatiques *(14,7 $ millions)*

Pour combler une lacune dans l'apprentissage des langues et des réalités asiatiques de sorte que les Canadiens, surtout ceux du secteur privé, puissent mieux traiter avec la région et tout particulièrement avec le Japon.

i) **Financement d'instituts de langues :** financement de base de deux grands instituts nationaux déjà existants offrant au secteur privé une formation linguistique et culturelle «de survie». Financement moins important pour la préparation de programmes d'études et pour l'embauche de personnel dans d'autres centres régionaux, y compris les programmes et les cours itinérants d'initiation à la manière de traiter les affaires en Asie. Création d'une base de données sur l'emploi et le resserrement des liens entre les études professionnelles et asiatiques dans les établissements post-secondaires.

ii) **Participation à une formation linguistique :** frais d'étude et de logement pour des jeunes gens d'affaires qui suivent des cours approuvés de langue.

iii) **Études asiatiques :** appui des associations d'études asiatiques et des conférences sur l'Asie, et de la participation d'universitaires aux conférences de gens d'affaires.

iv) **Activités des écoles secondaires :** soutien de l'amélioration des programmes d'études et d'autres programmes de sensibilisation menés dans des écoles secondaires.

v) **Développement de l'enseignement du japonais :** financement pour permettre à des enseignants japonais de venir au Canada enseigner au niveau secondaire et tertiaire pour combler la demande à court terme. Appui à la formation de professeurs de japonais.

d) Fonds pour les projets Pacifique 2000 (*11,4 $ millions*)

Pour permettre au Canada de mieux projeter sa présence dans la région Asie-Pacifique et d'assumer un rôle correspondant à ses intérêts et à ses priorités sur les questions clés.

i) **Programmes de relations stratégiques :** financement de grandes activités comme les «semaines du Canada», les «mois du Canada», et des séminaires sur des questions clés.

ii) **Jeunes leaders :** financement de visites au Canada effectuées par de jeunes leaders et représentants des médias asiatiques, échanges de parlementaires et de stagiaires parlementaires.

iii) **Éducation internationale :** Promotion des services canadiens d'éducation; encouragement de projets en association avec des établissements d'enseignement asiatique.

iv) **Recherches sur l'Asie et le Pacifique :** Appui de recherches menées dans les domaines de politique prioritaires en concentrant l'attention sur les intérets et les objectifs canadiens.

v) **Soutien de la participation aux institutions du Pacifique :** appui au budget du fonctionnement du Conseil national Canadien pour la coopération économique avec la région du Pacifique (PECC) et participation aux nouvelles institutions économiques de la région du Pacifique.

vi) **Fondation Asie-Pacifique :** Contribution au budget de base de la FAP.

Pour les concepteurs de cette stratégie, les recherches clés[13] conduites en collaboration avec les institutions académiques pourraient se distribuer ainsi :

a) sur le plan politique et stratégique:

i) les changements liées aux facteurs géostratégiques, la réduction des tensions Est-Ouest, la politique d'ouverture du président Gorbatchev à l'égard de la région, l'avenir de la Chine, la montée du Bassin du Pacifique comme puissance politique, et l'incidence de ces diverses tendances sur nos intérêts et notre rôle.

ii) la nature des conflits régionaux, les intérêts que défend le Canada et le rôle qu'il peut être appelé à jouer quant à leur règlement au Cambodge et en Corée, par exemple.

iii) l'adoption de mesures visant à instaurer la confiance en Asie-Pacifique, la pertinence du contrôle des armements et des mesures de désarmement dans la région.

b) sur le plan économique et commercial :

i) les conséquences de l'appréciation du yen pour les Canadiens, la restructuration industrielle dans la région et les débouchés qui s'offrent au Canada en matière de commerce et d'investissement.

ii) l'incidence des litiges commerciaux et des transactions commerciales bilatérales.

iii) les répercussions de l'Accord de libre-échange sur les investissements effectués au Canada par les pays de la région Asie-Pacifique.

iv) les apports de capitaux et d'investissement dans la région.

v) les nouvelles activités scientifiques et technologiques dans la région.

c) sur le plan stratégique :

i) analyser les pratiques commerciales asiatiques.

ii) promouvoir l'image du Canada dans la région et concevoir des stratégies pour la rehausser.

iii) conduire des recherches sur l'incidence de l'investissement, du tourisme et de l'immigration asiatiques au Canada.

iv) encourager les études asiatiques au Canada et trouver les moyens d'accroître leurs répercussions.

«Notre système d'enseignement, déclarera l'un des principaux auteurs de cette stratégie aux Affaires extérieures, David Preston, doit réorienter ses programmes afin de mettre davantage l'accent sur l'Asie, son histoire, sa vie politique, sa culture et les débouchés qu'elle peut offrir. À titre d'exemple, le gouvernement de la Colombie-Britannique prévoit y consacrer 11 millions de dollars en trois ans. Les fonds consacrés aux activités du programme de compréhension des langues et des cultures seront accordés avec la contrepartie des provinces et du secteur privé, afin de garantir une volonté de participation de part de d'autre».[14]

Un tel énoncé de politique constitue certes un point tournant pour nos relations avec la région. Bien que d'aucuns soient critiques du fait que cette stratégie accorde seulement une position sectorielle aux universités du pays, une position enchâssée dans des objectifs d'abord et avant tout d'ordre commercial, le public cible prioritaire demeurant, semble-t-il, le secteur privé, l'inventaire des projets de recherche proposé par l'ancien directeur adjoint du pupitre de la division du Pacifique aux Affaires extérieures et Commerce extérieur Canada offre un éventail de problématiques permettant de dépasser cette critique, à vrai dire, offre une ouverture complémentaire.

En outre, c'est avec la pratique que l'on verra si, oui ou non, le volet de formation linguistique et culturelle n'est qu'un simple «palliatif» ou «bouche-

trou», ou s'il constitue de fait une pierre angulaire de cette politique. Le choix initial des premiers projets en ce sens à Simon Fraser University et au Joint Centre de York et de Toronto, ainsi qu'à l'Université Laval, fait preuve d'un discernement et d'une analyse très pertinente de la situation, et du bassin d'expertise.

Il importe de préciser que cette stratégie s'articule de façon complémentaire à l'excellent programme d'études canadiennes[15] dans la région administré par la Division des relations académiques du même ministère; elle assure le développement de toute une série de centres d'études canadiennes partout dans la région faisant aujourd'hui preuve d'une qualité de production académique analogue à celle de nos centres d'études asiatiques au Canada.

Cette stratégie constitue donc comme un nouveau cadre de référence aux enjeux définis antérieurement. Une énigme demeure, toutefois : qui assumera le rôle de médiateur, d'interlocuteur, au niveau national canadien, permettant d'orienter l'opérationalisation de certains volets de cette stratégie avec les dilemnes et les contradictions discutés dans les volets antérieurs de cet essai?

Qui pourrait tenter d'assumer ce rôle de concertation entre les grands intervenants canadiens dans la région, soit du côté gouvernemental (les Affaires extérieures, l'ACDI), non gouvernemental (le CRDI, l'AUCC, l'ACCC, l'EUMC, le BCEI), ainsi que du côté des universités et des initiatives de leurs Centres d'études asiatiques et de chaque Bureau de coopération internationale? Qui?[16]

EN GUISE DE CONCLUSION

Une hypothèse s'impose, suite à cette dernière énigme : la Fondation Asie-Pacifique constitue une plate-forme privilégiée[17] pour tenter d'assumer ce nouveau rôle de concertation entre les différents intervenants, tant au plan national canadien qu'en relation avec nos interlocuteurs et partenaires de la région du Bassin du Pacifique.

À l'intérieur de cette Fondation, la vice-présidente aux affaires académiques représentera un nouveau type d'acteur dans le système, qui pourra, ou non, assumer un rôle majeur sinon de leadership, du moins de «trickster», de médiateur, afin d'assurer que le secteur académique ne devienne pas un simple «parent pauvre» de cette stratégie.

Nul doute que le Comité des relations internationales de la Société royale du Canada pourrait offrir une nouvelle plate-forme en termes d'initiative et surtout de concertation, avec un légitimité exceptionnelle d'universitaires au sommet de leur carrière, pour dépasser les contraintes et les priorités spécifiques de chaque groupe d'intérêt en présence aux niveaux micro, méso et macro et, de pair avec la Fondation Asie-Pacifique du Canada et son vice-président académique, offrir de nouvelles voies permettant d'assurer que nous devenions, à part entière, un pays membre de la région du Bassin du Pacifique.

Mais à court terme, et en guise de conclusion, j'aimerais profiter de cette occasion et attirer votre attention sur un problème concernant un peu plus de

8 500 «scholars» qui, pour l'instant du moins, ont choisi, suite au refroidissement du «Printemps de Pékin», de demander le statut de résident permanent au Canada.

Nos collègues du pupitre éducation de l'Ambassade de Chine à Ottawa affirment «qu'en acceptant ainsi de leur accorder ce statut, le Canada procède à un "brain drain" incroyable et que nous profitons de la situation».[18]

Nous nous devons de constater que, bien au contraire, ces étudiants gradués et/ou ces professeurs au milieu de leur carrière éprouvent de nombreuses difficultés à s'intégrer au sein de nos milieux universitaires, leurs bourses étant expirées, et ayant beaucoup de difficultés à survivre. Nous ne disposons pas de mécanismes institutionnels nous permettant de les intégrer. Et leur présence parmi nous, leurs tentatives de «lobbying» pour des postes d'assistants de recherche ou d'enseignement contribuent de beaucoup à ce stéréotype initial selon lequel le «juste équilibre» a été rompu.

Je crois que nos collègues de l'Ambassade de Chine à Ottawa, malheureusement diraient d'aucuns, se trompent. Nous ne «profitons» pas de la situation, bien au contraire. Nous ne savons même pas comment les intégrer un tant soit peu parmi nous.

Peut-être que, celles et ceux parmi nous qui, il y a un an de cela, jour pour jour en juin dernier, utilisaient cette rhétorique des «droits de l'hommes» seront d'accord avec moi : nous voilà confrontés avec le premier test concret de notre stratégie Pacifique 2000 : saurons-nous, ou non, les intégrer au sein de notre système d'éducation et de recherche, pendant qu'ils et qu'elles souhaiteront demeurer parmi nous?

Ce test, c'est à chacune et à chacun de nous, aujourd'hui ainsi qu'au sein de chacune des institutions impliquées dans ces échanges, qu'il convient de donner sa réponse à cette situation dramatique.

NOTES

1. La stratégie «Pacifique 2000» fut annoncée par le très honorable Brian Mulroney à l'Institut des études du sud-est asiatique à Singapour, le 15 octobre 1989.
2. De façon paradoxale, ce type de logique d'argumentation se retrouve tant au sein d'universités regroupant déjà des cohortes considérables d'étudiants en provenance de la région, que les jeunes avec un faible contingent d'étudiants étrangers.
3. Bureau canadien de l'éducation internationale, 1989 : 12.
4. Dans un rapport publié en 1981 par le BCEI intitulé *Un juste équilibre*, la Commission sur les politiques relatives aux étudiants étrangers s'inquiétait sur le vide politique entourant la nouvelle loi sur l'immigration et l'imposition de frais de scolarité majorés, et mettait de l'avant le principe qu'aucun programme ou département ne devrait être dominé par une nation quelconque. Mais ce concept a évolué depuis 1981. Toutefois, même si nous avons accueilli des milliers d'étudiants étrangers, nous avons fait très

peu pour échanger avec eux afin de comprendre ce qui se passe chez eux, surtout pour ceux en provenance de pays en voie de développement.

5. Les deux objectifs des programmes d'aide de l'ACDI dans la région se formulent ainsi : «premièrement, renforcer les grandes organisations publiques et privées pour qu'elles puissent se doter des compétences administratives et techniques que requiert l'établissement de lignes de conduite et de programmes conformes aux objectifs nationaux du développement; deuxièmement, créer entre institutions asiatiques et canadiennes des liens propres à amener des relations durables qui correspondent à la fois aux priorités de développement asiatiques et aux intérêts à long terme du Canada dans la région de l'Asie et du Pacifique», *Rapport annuel 1988-89* : 37.
6. À la différence des deux objectifs de l'ACDI, le CRDI vise d'abord et avant tout à consolider le potentiel de recherche au sein même des institutions des pays en voie de développement, avec des projets qui même s'ils ne correspondent pas à des priorités pour le Canada, constituent néanmoins des priorités pour le développement local et en relation avec les besoins de base. Les résultats de certains projets concernant le bamboo par exemple, bien que n'ayant que peu de pertinence pour des intérêts canadiens, ont atteint une réputation internationale dans la région pour les pays concernés.
7. Le Secrétariat est situé au sein de la Division internationale de l'AUCC et est administré par le D[r] Lolan Grady.
8. Le Secrétariat est situé au Joint Centre des universités York et Toronto pour les études sur l'Asie et le Pacifique et est administré par le D[r] B. Michael Frolic.
9. Ces deux types d'approche présentent toutes deux des inconvénients marqués, surtout lorsqu'une même université signe plusieurs protocoles ouverts avec une série d'universités du même pays, les mettant ensuite en compétition lors des demandes de subventions. Quant à l'approche où la subvention devrait être accordée préalablement à la signature d'un protocole, on la retrouve surtout dans les universités plus jeunes ou disposant de moins de programmes d'échanges avec la région; l'on assite alors à un «cercle vicieux», la plupart des organismes subventionneurs exigeant au préalable un cadre de référence précis.
10. Nos anciens homologues au sein de la Commission d'État à l'Éducation en Chine nous ont, à maintes reprises, avoué qu'il leur était très difficile de comprendre l'approche fragmentée, sectorielle, des multiples délégations canadiennes, en comparaison avec l'approche beaucoup plus intégrée ou concertée des autres pays.
11. Décision prise en 1987, qui provoqua une série de protestations des milieux académiques, et qui à ce jour, n'a pas encore été modifiée.
12. Commission royale d'enquête sur l'union économique et les perspectives de développement du Canada, 1985, Volume 2; Paquet et Von Zur-Muehlen, 1987.

13. Pour une analyse plus détaillée de ces types de projets clés de recherche, l'on pourra consulter l'article de D. Preston dans *Asia Horizon Asie*, Vol. XI, N° 3, 1989 : 15 22.

14. *Ibid.*, 22

16. Ce programme subventionne les centres d'études canadiennes dans la région, du Japon à l'Inde, en passant par la République de Corée, l'Australie et certains pays de l'ANASE. Il offre également des programmes de bourses dites «Faculty Exchange Program» pour la création de nouveaux cours sur le Canada et «Faculty Research Program» pour la rédaction et la publication d'articles sur des problématiques canadiennes. Enfin, il offre un support considérable en termes de publications pour les bibliothèques des universités où l'on offre des cours sur le Canada.

    Ce type de programme est un peu le pendant aux programmes de subvention Tanaka et Nakasone administrés par la Division des relations internationales de l'AUCC, pour les centres d'études asiatiques au Canada (Voir AUCC 1989).

    Le prochain congrès international de l'Association internationale d'études canadiennes aura lieu dans la région, plus précisément à l'Université de Beijing, en juillet 1990, avec des participants de 24 pays. L'on pourra consulter l'article de Artibise dans le prochain numéro de la *Revue d'études candiennes* (sept 1990) qui présentera un bilan des études canadiennes en Asie.

17. Jusqu'ici et par rapport à d'autres régions, l'AUCC a assumé un rôle clé en termes de concertation et de circulation d'information. Dans le contexte du Pacifique, elle a aussi développé une expertise exceptionnelle, surtout depuis qu'elle est devenue l'agence d'exécution canadienne pour le programme sino-canadien de jumelage inter-universitaire, qui en arrivera bientôt à son troisième cycle (Voir PSCJU, *Bulletin d'information*). En outre, elle administre également depuis leurs débuts les programmes Tanaka et Nakasone, et vient de soumettre, au terme d'un processus de consultation, une série de propositions pour la consolidation de ces programmes auprès des autorités de l'Ambassade du Japon au Canada (voir AUCC 1989).

    Un trait distinctif toutefois mérite d'être souligné. De par les institutions et groupes d'intérêt qu'elle représente, la logique d'argumentation que défend sa Division de coopération internationale privilégie les initiatives individuelles au sein de chaque institution, comme principal mécanisme de coopération. Si cette logique s'avère sans doute la plus pertinente dans des contextes où il existe déjà une bonne tradition de recherche et de coopération inter-institutionnelle, peut-être y a-t-il lieu d'y apporter quelques nuances en «pianissimo» ou en «piano» lorsque ces projets concernent une région où l'expertise est plus récente. Très peu d'universités canadiennes peuvent gagner, pour l'instant du moins, certaines des grandes demandes de soumission auprès des organismes bilatéraux, la Banque Asiatique de Dévelppement et d'autres. Notre propre

expertise canadienne par rapport à cette région est, elle-même, «en voie de développement».

En outre, quand un autre grand organisme comme le CRSH décide unilatéralement d'abolir ses programmes de coopération inter-institutionnelle avec des pays de la région, dont la Chine et le Japon, quel autre organisme peut protester, et y substituer les fonds nécessaires pour la relance de ce type de programmes?

17. Les subventions accordées par le Ministère des Affaires extérieures et par la Fondation Asie-Pacifique ainsi que leur participation aux séances plénières du dernier congrès annuel de l'Association canadienne d'études asiatiques à Victoria en mai 1990 («Les états côtiers du Pacifique et le nouveau virage des relations internationales des années '90», ainsi que «Les relations nippo-canadiennes : Le défi des années '90») en constituent un exemple éloquent.
18. Analyse de M. Tian Xiao Gang, premier secrétaire, Ambassade de Chine à Ottawa, lors d'une entrevue accordée en mai 1990.

ANNEXE

Légende explicative des divisions régionales utilisées dans le tableau 1 et la figure 1

Asie du Sud-Est	Asie de l'Est	Autre Asie
Birmanie	Corée, Rép.	Afghanistan
Brunei	Corée, Rép. dém. pop.	Arabie saoudite
Chine (Rép. pop.)	Hong-Kong	Bahraïn
Indonésie	Japon	Bangladesh
Kampuchéa	Macao	Bhoutan
Laos	Taiwan	Chypre
Malaisie		Émirates arabes unis
Philippines		Inde
Singapour		Iran
Thaïlande		Iraq
Viêt-Nam		Israël
		Jordanie
		Koweït
		Liban
		Maldives
		Népal
		Oman
		Pakistan
		Palestine
		Qatar
		Sri Lanka
		Syrie
		Turquie
		Yémen
		Yémen (SANA)
		Non déclaré

Source : BCEI, 1989 : 64

RÉFÉRENCES

ACDI, *Rapport annuel 1988-89*, Ottawa, ministère des Approvisonnements et Services, 1989.

AUCC, *ia Revue des programmes de subventions Tanaka et Nakasone*, sous la direction de Eva Egron-Polak et Ken Doiron, Ottawa, 1989.

AUCC, *Nouvelles du PSCJU/CCULP News*, Bulletin d'information du Programme sino-canadien de jumelage universitaire, vol. 1, n° 1., 1989.

BCEI, *Profil des étudiants étrangers au Canada 1989*, *Magazine de l'éducation internationale*, vol. 5, n°s 4/5, juillet/octobre 1989.

Commission royale d'enquête sur l'union économique et les perspectives de développement du Canada, *Rapport*, vol. 2, Ottawa, ministère des Approvisionnements et Services, 1985.

CRDI, *Rapport annuel 1988-89*, Ottawa, CRDI, 1989.

Ministère des Affaires extérieures et du Commerce extérieur Canada, *Rapport annuel 1988-89*, Ottawa, ministère des Approvisionnements et Services, 1989.

OCDE, «Les étudiants étrangers et l'internationalisation de l'enseignement supérieur». Document de travail préparé pour le 2e colloque international sur l'enseignement supérieur et le mouvement des étudiants étrangers, Hiroshima, novembre 1988, Paris, OCDE, 1988.

Paquet, G., «Post-Secondary Education : An Enterprise Less Than Optimally Managed?», dans G. Paquet et Max von Zur-Muehlen, *Education Canada? Le postsecondaire en crise*, 2e éd, Ottawa, Le Réseau canadien de recherches pour l'enseignement supérieur, 1987.

Preston, D., «Research Needs and Programs», *Asia Horizon Asie*, vol. XI. n° 3, 1989. p. 15 à 22.

Simpson, D., et C. Sissons, *Entrepreneurs en éducation : La réponse du Canada au défi international du développement des resources humaines*, 62e étude technique, Ottawa, CRDI, 1989.

JACQUES LAMONTAGNE*

L'enseignement supérieur en Chine : développements récents†

Cet exposé fait état des grandes lignes du développement de l'enseignement supérieur en Chine pendant les années quatre-vingt, en abordant les rubriques suivantes : (a) la réforme de l'éducation; (b) les institutions d'enseignement supérieur; (c) la coopération internationale. Nous retiendrons particulièrement les facteurs qui ont pu contribuer à diminuer ou à augmenter les disparités éducatives entre régions et groupes sociaux.

LA RÉFORME DE L'ÉDUCATION

En mai 1985, le Comité central du PCC adopta la «décision de réformer le système d'éducation». Cette réforme portait sur les trois niveaux d'éducation : primaire, secondaire et universitaire, et devait accompagner la réforme de l'économie dans les campagnes et les villes. Essentiellement, il s'agissait de répondre au besoin accru de personnel qualifié. Les problèmes à résoudre étaient de rattraper le retard dans l'universalisation de l'enseignement primaire, de restructurer l'enseignement secondaire afin d'assurer une place beaucoup plus grande à l'enseignement professionnel et technique, de modifier la structure et la composition inadéquates des disciplines de l'enseignement supérieur et de décentraliser le contrôle de l'éducation relativement à des questions concrètes et locales, en même temps que de renforcer l'autorité centrale en matière de planification et de coordination. Le principe fondamental de la réforme est que l'éducation occupe une place stratégique dans les quatre modernisations. Plus de fonds sont alloués à l'éducation pour que celle-ci accomplisse sa mission, mais on cherche aussi à rationaliser les coûts de l'éducation.

Au niveau primaire, on universalise progressivement l'enseignement obligatoire de neuf années : d'abord dans les villes et les provinces côtières, ensuite dans les bourgs et les régions rurales semi-développées, puis dans les

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régions reculées et attardées. À cet effet, on augmente le nombre d'enseignants qualifiés, et l'on confie aux gouvernements locaux la responsabilité de développer l'enseignement primaire et secondaire.

Au niveau secondaire, on développe à un rythme accéléré l'enseignement professionnel et technique, qui avait été réduit presque à néant pendant la Révolution culturelle. Pour favoriser ce changement, on demande aux entreprises d'exiger de leur personnel technique qu'il possède des certificats de qualification, et aux gouvernements locaux d'encourager des individus et des collectivités à fonder et à gérer des écoles techniques et professionnelles.

L'enseignement supérieur doit être adapté aux besoins du développement socio-économique de chaque région. Le système de recrutement des étudiants et d'assignation des diplômés à des unités de travail est modifié, et le pouvoir de décision de chaque université en matière de relation avec sa région est accrû. On recrute des étudiants sur la base de commandes effectuées par des unités de travail comme supplément au plan de recrutement d'État. On contingente les étudiants recrutés qui sont appelés à travailler dans des régions éloignées ou dans des occupations dont les conditions d'exercice sont particulièrement rudes. Pour soulager le fardeau financier des universités, on leur permet d'admettre, en dehors du plan d'État, des étudiants qui paient leurs propres frais de scolarité et autres dépenses. On a prévu même que les institutions d'enseignement supérieur, à l'exception de celles qui sont chargées de la formation de maîtres, exigent de leurs étudiants réguliers le paiement des frais de scolarité, de logement et de nourriture.

Le ministère de l'Éducation est transformé en Commission d'État à l'éducation, dont les responsabilités sont l'orientation et la planification de l'éducation, la coordination des ministères en matière d'éducation et l'implantation de la réforme de l'éducation. Parallèlement, le pouvoir des universités est accrû : les présidents d'université ont plus de responsabilités et sont entourés d'un conseil et d'une assemblée de professeurs.

La formation du personnel professionnel et technique

On s'applique à contrer la tendance à l'augmentation de la proportion d'étudiants dans des institutions supérieures, et, à la place, à mettre l'accent sur la formation du personnel requis par la société. On voudrait minimiser les différences de statut social attribuées aux diverses professions et maximiser la capacité d'adaptation des occupations aux besoins socio-économiques régionaux. Des études sont menées sur les diplômés pour évaluer leur performance au travail et leur adaptation dans la société. En pédagogie, on voudrait appliquer le principe selon lequel l'enseignement doit être adapté à la majorité des étudiants : cela va à l'encontre de l'intérêt porté aux enfants doués et au développement d'écoles de pointe pour les élèves les plus performants. Afin de détourner l'attention de la préparation aux études de niveau supérieur, on opte pour l'abolition de l'examen d'entrée à l'école secondaire de premier cycle et, dans l'évaluation des écoles, on examine comment la formation des étudiants est reliée à leur performance au travail, plutôt que de compter la proportion de diplômés qui poursuivent des études à un niveau supérieur. Le

facteur clé dans l'administration de l'éducation est donc le lien entre le système d'éducation et le monde du travail, le principe étant «la formation d'abord, l'emploi ensuite», afin de favoriser le développement de la formation professionnelle et technique.

L'universalisation de l'enseignement obligatoire de neuf années
La loi sur l'enseignement obligatoire, en vigueur depuis le 1er juillet 1986, prescrit que l'universalisation de l'enseignement obligatoire de neuf années doit s'accomplir progressivement, eu égard aux conditions locales, c'est-à-dire aux inégalités culturelles et économiques dans les provinces, les préfectures, les districts et les cantons. Deux phases sont prévues : l'universalisation de l'enseignement primaire (6 années), puis celle de l'enseignement secondaire de premier cycle (3 années). Dans chaque localité, on se concentrera sur l'universalisation de l'enseignement primaire avant de mettre l'accent sur l'enseignement secondaire de premier cycle.

La restructuration de l'éducation
Au niveau secondaire, on continue d'augmenter la part de l'enseignement professionnel et technique : en termes d'effectifs, cette part était passée de 5 % à 36 % de 1978 à 1985. Au niveau universitaire, on développe encore plus l'enseignement professionnel de cycle court introduit en 1980, on augmente les effectifs dans certaines disciplines, en particulier l'administration, les finances et l'économique, et l'on continue de développer d'autres formes d'enseignement supérieur, telles que la télé-université, les universités du soir et les universités par correspondance. Dans le processus de restructuration de l'éducation, on met l'accent sur l'étude à des fins d'application et de résultats pratiques, plutôt que sur l'aspiration à des niveaux d'éducation plus élevés.

La réforme de l'administration de l'enseignement supérieur
Les changements apportés à l'administration de l'enseignement supérieur sont fondés sur le principe du renforcement de l'administration centrale en matière de planification et de coordination et de l'accroissement du pouvoir de décision de chaque institution d'enseignement supérieur dans des questions concrètes et locales. Le pouvoir de chaque institution d'enseignement supérieur couvre, notamment, les modifications de programmes, les méthodes d'enseignement, l'administration des affaires étudiantes et l'administration de la recherche. Les universités professionnelles de cycle court, qui relèvent des villes, sont les seules à ne pas dépendre d'un gouvernement provincial ou du gouvernement central. Cependant, toutes les institutions d'enseignement supérieur sont autorisées à établir des liens horizontaux de collaboration inter-universitaires à l'intérieur d'une même région ou entre régions. Le recrutement des étudiants est divisé en trois types : selon les plans d'État, selon des demandes d'unités de travail et selon des demandes d'admission individuelles par des étudiants qui déboursent eux-mêmes les frais encourus. Un nouveau système de bourses et de prêts est adopté en juillet 1986; la priorité est d'abord accordée aux excellents dossiers académiques, à certains domaines (formation des maîtres,

agriculture, nationalités minoritaires, etc.) et à ceux qui travailleront dans des régions éloignées ou dont les conditions de travail seront particulièrement difficiles. En éducation des adultes, un pas en avant est franchi, en 1986, par l'administration d'examens nationaux unifiés pour l'enseignement supérieur aux adultes.

Le renouvellement du contenu et des méthodes d'enseignement
Des cours d'application et des cours interdisciplinaires sont ajoutés dans les programmes d'études. On recourt aux méthodes d'enquête sociale pour intégrer la théorie et la pratique et pour développer chez les étudiants la capacité d'analyser et de résoudre des problèmes. Les méthodes d'enseignement mettront l'accent sur le développement de la capacité de réflexion et de travail autonome des étudiants, au moyen de discussions en classes et de séminaires. La pédagogie traditionnelle fait place à la méthode heuristique.

Le renforcement de la profession enseignante
Pour pallier la grave pénurie d'enseignants qualifiés, la priorité est accordée aux instituts de formation des maîtres dans le recrutement des étudiants au niveau provincial, et des cours de perfectionnement télévisés sont conçus à l'intention des enseignants du primaire et du secondaire.

Amélioration de la législation scolaire
Après l'adoption, en 1986, de la loi sur l'enseignement obligatoire, plusieurs autres lois ont été adoptées à l'échelon national, notamment, des lois sur l'enseignement supérieur, l'enseignement professionnel et technique, l'administration des personnes étudiant à l'étranger, l'établissement d'institutions d'enseignement supérieur, la création de programmes d'études supérieures et l'établissement d'écoles secondaires professionnelles et techniques. De même, les autorités provinciales ont adopté plusieurs lois relevant de leur juridiction.

LES INSTITUTIONS D'ENSEIGNEMENT SUPÉRIEUR

Les institutions régulières d'enseignement supérieur
De 1980 à 1985, le nombre d'institutions régulières d'enseignement supérieur s'est accru considérablement, passant de 675 à 1 016. Les universités professionnelles de cycle court, dont les débuts remontent à 1980, ont rapidement proliféré : on en comptait 140 en 1987. Les autres types d'institutions qui ont le plus progressé sont les instituts de formation des maîtres (de 172 à 253), les instituts de science politique et de droit (de 7 à 24) et les instituts de finance et d'économique (de 30 à 62). Les effectifs en sciences humaines et sociales sont passés de 5.3 pour cent à 10.8 pour cent du total des effectifs. La proportion des étudiants admis dans les programmes de cycle court, par rapport à l'ensemble, a grimpé de 27 pour cent à 49 pour cent.

On compte maintenant quatre types d'institutions régulières d'enseignement supérieur : les universités sous la juridiction de la Commission d'État à l'éducation, les université et les instituts spécialisés administrés par divers ministères, les institutions sous juridiction provinciale et les universités professionnelles de cycle court sous juridiction municipale.

Les universités professionnelles de cycle court ont pour but de répondre aux besoins de main-d'œuvre au niveau de la ville dont elles dépendent. Le recrutement de leurs étudiants se fait localement. Il n'y a pas de résidence d'étudiants dans les locaux des universités, et l'on exige des frais de scolarité. Les diplômés doivent trouver leur propre travail, mais les universités reçoivent l'appui d'entreprises désireuses d'embaucher des catégories prédéterminées de spécialistes. Ces universités sont autorisées à créer et à modifier leurs programmes; ainsi, elles peuvent répondre rapidement aux besoins locaux du marché du travail. Par ailleurs, les universités professionnelles de cycle court se sont regroupées en association, en 1984, dans le but de coopérer à la formulation de plans d'études et de syllabus pour les programmes nouvellement créés. Ces universités sont réparties sur tous les territoires de niveau provincial, sauf au Qinghai, mais elles sont relativement plus nombreuses dans les territoires les plus urbanisés, en particulier dans la région Nord-est et région Sud-est.

La télé-université

La télé-université est la forme d'enseignement supérieur pour adultes dont l'essor est le plus remarquable. Son origine remonte à l'année 1960, alors que des émissions éducatives desservaient la région de Beijing. Pendant ses six premières années, elle a diplômé quelque 8 000 personnes et dispensé des cours hors programme à quelque 50 000 personnes.

La Radio-télé-université centrale (CRTVU) a été créée en 1978, puis, successivement, sont nées des télé-universités dans 28 des 29 territoires de niveau provincial (PTVU). L'administration de la télé-université est complétée par 279 écoles préfectures/villes et 625 stations de travail quartiers/districts. Certaines industries sont aussi responsables de stations de travail.

De 1979 à 1986, 1 291 833 personnes ont été diplômées par la télé-université et 456 959 autres y sont suivi un cours hors programme. L'année 1986 a marqué un point tournant, alors que trois changements ont été apportés : (a) les examens d'entrée de la Commission d'État à l'éducation ont été imposés à toutes les institutions d'enseignement supérieur pour adultes; (b) on a commencé à accepter des diplômés frais émoulus d'écoles secondaires; (c) la transmission par satellite a été inaugurée, permettant d'atteindre tous les coins du pays. Dans les années 1990, on prévoit qu'environ 40 % des étudiants universitaires seront inscrits à la télé-université.

LA COOPÉRATION INTERNATIONALE

Les projets de la Banque Mondiale

La Chine a été reconnue comme un pays en voie de développement par l'OCDE en 1979, et est devenue membre de la Banque Mondiale en 1980. Aussitôt des projets de développement de l'éducation ont été élaborés.

Les prêts scolaires de la Banque Mondiale remontent à 1962. En 1974, puis en 1980, la Banque énonça une politique mettant l'accent sur quatre principes : l'éducation de base, la main-d'œuvre, l'efficacité et l'égalité des chances. On devait donc concentrer les prêts de la Banque sur les projets d'éducation primaire et d'enseignement secondaire techniques reliés aux besoins de main-d'œuvre. Cependant, les niveaux primaire et secondaire en Chine se comparaient avantageusement à ceux des autres pays en voie de développement, alors que les effectifs universitaires chinois étaient de beaucoup moindres que ceux des autres pays. Par conséquent, la Chine obtint de la Banque Mondiale que l'enseignement supérieur reçoive la première priorité pour les prêts de la Banque.

On élaborera huit projets d'enseignement supérieur à être réalisés pendant les années 1980. Ces huit projets portent sur les trois échelons — national, provincial et local — et couvrent la plupart des régions du pays. Au total, 183 des 1 016 universités en ont bénéficié, dont 86 universités de niveau provincial ou local. Le premier projet visait le renforcement de l'enseignement et de la recherche dans 28 universités nationales de pointe en sciences pures et ingénierie. Trois autres projets étaient centrés respectivement sur l'agriculture, la santé rurale et l'éducation médicale. Un projet se divisait en deux volets : les universités professionnelles de cycle court et la télé-université. Le projet le plus dispendieux — 1 162 000 000 US $ — avait pour but l'expansion des effectifs de premier cycle en génie, en économique, en finance et en droit, et regroupait 39 institutions d'enseignement supérieur. Le huitième projet était à l'intention des universités provinciales : 60 en ont bénéficié (4 universités normales régionales gérées par la Commission d'État à l'éducation, 24 universités normales provinciales, 18 universités générales provinciales et 14 instituts spécialisés en technique, en médecine et en agriculture). Tous les projets, sauf celui en santé rurale et éducation médicale, étaient supervisés par un comité international d'universitaires conjointement avec un comité d'universitaires chinois. Au total, les huit projets ont coûté 2 865 000 000 US $ et les crédits de la Banque se sont élevés à 804 000 000 US $. Chacun des projets comportait, entre autres, le financement d'étudiants chinois à l'étranger.

Les étudiants chinois à l'étranger

En 1978, le gouvernement chinois décida d'augmenter considérablement le nombre d'étudiants envoyés à l'étranger. De 1978 à 1984, 26 500 étudiants ou chercheurs ont été envoyés dans 63 pays pour des séjours de plus de six mois. À ce nombre s'ajoutent quelque 8 000 étudiants qui sont allés à l'étranger par leur propres moyens. Les États-Unis ont reçu 45 % des étudiants envoyés

pendant cette période, le Japon 14 pour cent, la RFA 9 pour cent, le Royaume-Uni 7 pour cent, le Canada 7 pour cent et la France 5 pour cent. Les domaines choisis par le plus grand nombre étaient les sciences naturelles (29 %) et l'ingénierie (38 %). Les sciences humaines et sociales ont recueilli 14 pour cent. Le territoire de provenance des étudiants commandités par le gouvernement de 1978 à 1984 était surtout Shanghai, Beijing et Tianjin (63 pour cent du total).

Chaque année, la Commission d'État à l'éducation, la Commission d'État à l'économie et la Commission d'État à la science et à la technologie délibèrent pour déterminer le nombre d'universitaires à envoyer à l'étranger par domaine et niveau d'études, en relation avec le plan quinquennal de développement. L'application des programmes relève de la Commission d'État à l'éducation. Celle-ci détermine un quota pour toutes les unités : (a) chacune des 38 universités administrées par la CEE; (b) chaque ministère responsable d'enseignement supérieur spécialisé; (c) chaque Bureau provincial d'enseignement supérieur; (d) l'Académie des sciences; (e) l'Académie des sciences sociales. En général, les institutions d'échelon national sont favorisées dans les quotas. Initialement, en 1978, l'accent était mis sur des universitaires expérimentés qui effectuaient des stages de perfectionnement. À compter de 1980, on a plutôt favorisé des jeunes dans des programmes de maîtrise et de doctorat. Depuis 1986, on préfère envoyer des étudiants de doctorat, en misant sur la capacité d'accueil des universités chinoises au niveau de la maîtrise.

Les échanges universitaires entre la Chine et la Canada se situent dans le contexte des relations commerciales entre les deux pays. Celles-ci ont considérablement augmenté de 1978 à 1985. La portion canadienne des importations totales de la Chine a varié entre 4,5 pour cent et 6 pour cent, soit presque autant que celle de l'Allemagne de l'Ouest. De 1970 à 1983, 2 514 chercheurs et étudiants chinois sont venus au Canada dans le cadre d'ententes Canada/Chine. Plusieurs autres sont venus au Canada par des liens institutionnels inter-universitaires ou par des parrainages. L'ingénierie et les sciences pures, à elles seules, constituaient 45 pour cent des domaines de spécialisation.

L'année 1983 a été un point tournant alors que l'ACDI et MFERT (Ministère de l'économie et des relations commerciales étrangères) signaient une entente pour l'assistance canadienne au développement de la Chine. Le rationnel était que l'aide au développement est vitale pour le renforcement du commerce. L'aide canadienne est concentrée dans trois domaines : resources naturelles (énergie, sylviculture, agriculture, mines), infrastructure (pouvoir, transport, communications) et secteur social (éducation, santé, formation et administration). En 1984, on comptait 58 projets de développement couvrant tous les secteurs identifiés. Le budget total de la période 1984 à 1989 s'est élevé à 90 000 000 CAN $. Cet ensemble de projets a sans doute été un stimulant de premier ordre pour les échanges éducatifs.

CONCLUSION

Les développements récents de l'enseignement supérieur en Chine sont caractérisés par la décentralisation de plusieurs fonctions administratives et la diversification des formes d'enseignement supérieur. Nous avons remarqué, tout particulièrement, la prolifération d'universités professionnelles de cycle court et le développement accéléré de la télé-université. Ces phénomènes peuvent contribuer à renforcer les différences régionales et socio-économiques. Mais les changements effectués visent à «optimiser» les ressources disponibles en les adaptant aux conditions socio-économiques propres à chaque région. On pourra continuer d'observer une hiérarchie dans les institutions d'enseignement supérieur. Cependant, les nouvelles formes, bien que moins prestigieuses, jouissent d'une plus grande adaptabilité aux besoins de main-d'œuvre qualifiée. On prévoit que ce fort mouvement continuera de prendre de l'ampleur dans les années quatre-vingt-dix.

RÉFÉRENCES

China Handbook Editorial Committee. *Education and Science*, Beijing, Foreign Languages Press, 1983.

Dai Shujun. «Vocational Universities in China». *Canadian and International Education*, vol. 16, n° 1, 1987, p. 172 à 180.

Department of Planning, Ministry of Education, People's Republic of China. *Achievement of Education in China: Statistics 1949-1983*, Beijing, People's Education Press, 1985.

Department of Planning, State Education Commission, People's Republic of China. *Achievement of Education in China: Statistics 1980-1985*, Beijing, People's Education Press, 1986.

Gao Weizhen. «The Open Door and the Reform of Higher Education». *Chinese Education*, vol. 21, n° 1, p. 116 à 128.

Gu Mingyuan. «The Development and Reform of Higher Education in China». *Comparative Education*, vol. 20, n° 1, 1984, p. 141 à 148.

Hawkins, John N. «Higher Education Alternatives in China: The Transition from Revolutionary to Postrevolutionary Forms». *Comparative Education Review*, vol. 29, n° 4, novembre 1985, p. 425 à 439.

Hayhoe, Ruth. *China's Universities and the Open Door*, Armonk, N.Y., M.E. Sharpe, Inc., 1989.

He Dongchang. «The Program of Reform of the Educational System of China». Dans Wu Wei (éd.) *Educational Reform and Development in China*, Buffalo, N.Y., SUNY at Buffalo, 1987, p. 1 à 9.

Henze, Jürgen. «Higher Education: The Tension Between Quality and Equality». Dans Ruth Hayhoe (éd.), *Contemporary Chinese Education*, Armonk, N.Y., M.E. Sharpe, Inc., 1984, p. 93 à 153.

Huang Shiqi. «Contemporary Educational Relations with the Industrialized World: A Contemporary View». Dans Ruth Hayhoe et Marianne Bastid

(éds.), *China's Education and the Industrialized World: Studies in Cultural Transfer*, Armonk, N.Y., M.E. Sharpe, Inc., p. 225 à 251.

Lamontagne, Jacques. «Educational Development in the PRC: Regional and Ethnic Disparities». *Issues and Studies*, vol. 22, n° 9, septembre 1986, p. 73 à 94.

_____. «Le développement de l'éducation en Chine avant et pendant les années quatre-vingt». *Interchange*, vol. 19, n° 3/4, 1988, p. 38 à 54.

_____. *L'éducation en Chine : données statistiques*, Montréal, Faculté des sciences de l'éducation, Université de Montréal, 1989.

Liu Wenxiu. «Developments and Interrelationships of Higher Education in New China». *Canadian and International Education*, vol. 14, n° 2, 1985, p. 59 à 71.

Reed, Linda A. *Education in the People's Republic of China and U.S.-China Educational Exchanges*, Washington, D.C., NAFSA (National Association for Foreign Student Affairs), 1988.

Singer, Martin. *Relations universitaires du Canada avec la République populaire de Chine depuis 1970*. Volume 2 : *Échange des universités canadiennes avec la Chine*, Ottawa, CRDI (Centre de recherches pour le développement international), 1987.

Umakoshi Toru. «The Reform of Higher Education of China under the Modernization Policy». *East West Education*, vol. 8, n° 1, printemps 1987, p. 11 à 23.

Wu Wei. «Educational Reform Drive for Promotion of the Fundamental Undertaking of the Nation». *Bulletin of the UNESCO Regional Office for Education in Asia and the Pacific*, n° 27, novembre 1986, p. 147 à 163.

_____. «Current Educational Reform and Research in China». Dans Wu Wei (éd.) *Educational Reform and Development in China*, Buffalo, N.Y., SUNY at Buffalo, 1987, p. 10 à 25.

Zhao Yuhui. «China: Its Distance Higher-Education System». *Prospects*, vol. 18, n° 2, 1988, p. 217 à 228.

CLAUDE COMTOIS, FRANÇOIS SOULARD ET
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L'avant-pays canadien des ports chinois†

LE PROBLÈME

Le transport maritime et le commerce international sont interreliés dans leur développement. Trois éléments caractérisent l'évolution récente des échanges mondiaux.

Premièrement, une plus grande division de la production, contrainte par le vieillissement des infrastructures industrielles, transforma de façon marquée les conditions de fonctionnement du système économique international. Le changement le plus important consiste en la réduction de l'utilisation de matières premières pour la production de biens et d'énergie. La recherche systématique d'économie d'énergie dans tous les domaines d'activités économiques a accéléré la substitution de l'information aux matières premières, à l'énergie et à la force de travail. Toutes les industries lourdes à travers le monde sont affectées, particulièrement celles dépendant du commerce international et des échanges. En effet, la division internationale du travail n'offre pas aux pays qui produisent des matières premières et de l'énergie et qui possèdent une réserve importante de main-d'œuvre faiblement qualifiée, l'avantage de la capacité d'innover dans les secteurs industriels les plus évolués.

Deuxièmement, certaines pratiques reliées à la circulation physique des biens commencent à apparaître. Sans trop généraliser, les plus importants transporteurs maritimes éprouvent de la difficulté eu égard à plusieurs lignes de transit ou concernant le cargo spécialisé. Conséquemment, ces transporteurs intègrent à leurs stratégies de développement, les transformations de l'environnement économique mondial en offrant progressivement de nouveaux services de transport maritime international qui prennent en considération la spécificité des marchés. Ces transporteurs acquièrent leur propre autonomie et sont capables d'anticiper les attentes de leurs partenaires de transport (Stanley 1978, Stromme 1978).

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Troisièmement, le marché mondial tend à fragmenter le processus de travail de deux façons. D'une part, on observe une désintégration de la production caractérisée par un accroissement de la sous-traitance. D'autre part, la division internationale du capital opère à travers un ensemble de fonctions dans plusieurs pays, mais souvent à l'intérieur d'une même firme. La logique du mode de production générale se réalise à l'échelle mondiale, alors que la logique du fonctionnement des unités territoriales nationales est en soi souvent dépendante de circonstances culturelles particulières. Il en résulte une profonde divergence entre deux rythmes. Une nouvelle forme de dépendance des territoires nationaux envers les industries tend à apparaître : non sur les demandes de planifications territoriales de quelques entreprises, mais sur la domination de chaque système territorial national par une logique de marché mondial des firmes multinationales (Armstrong et McGee 1985).

Une des conséquences de ces diverses tendances sur l'organisation de l'espace industriel est le rôle fondamental que jouent les ports eu égard aux échanges internationaux. Mais le rythme et la logique de production trouvent leurs racines au niveau mondial et ainsi sont étrangers aux systèmes des ports nationaux. En conséquence, la réorganisation du transport maritime conduit à des opérations extrêmement complexes devant la diversité et l'hétérogénéité des acteurs.

Les ports en eux-mêmes n'accroissent pas le commerce mondial (Bird 1986, p. 160). Les activités portuaires sont une réponse à l'interdépendance des systèmes de transport terrestre et maritime. Néanmoins, le transport maritime, sur lequel reposent les principaux courants du trafic mondial, exerce souvent une action déterminante sur l'organisation spatiale. Le système portuaire chinois est d'une importance fondamentale pour le pays pour deux raisons : l'importance croissante du commerce extérieur dans le développement de l'économie chinoise et la localisation géographique du pays. Ainsi, en 1988, approximativement 178 millions de tonnes de biens importés pénétrèrent par transport maritime, alors que les marchandises exportées par les ports chinois représentèrent plus de 212 millions de tonnes du trafic (*China Statistics Monthly* 1989). Le peu d'études qui furent menées sur le système portuaire chinois, se sont essentiellement concentrées sur l'arrière-pays portuaire (Leung 1981, Comtois 1989). Mais, dans le domaine de la géographie des ports chinois, un des éléments les plus importants est la taille et l'économie des avant-pays.

La notion d'avant-pays est multidimensionnelle, beaucoup plus que celle d'arrière-pays. L'avant-pays est à la fois un espace maritime et terrestre (Marcadon 1986, p. 55). La notion d'avant-pays se modifie avec la spécialisation commerciale, les types de produits, et la fréquence de contact. La mesure de l'importance des flux entre deux pays est facilitée par l'existence de comptes rendus précis des flux d'échanges par type, valeur, et origine et destination géographique des produits transigés. Toutefois, une évaluation devient plus difficile lorsque la quantité de données disponibles est rare et les statistiques publiées sont relativement difficiles à obtenir (Li 1962; Chen 1967, 1975). Dans les pages qui suivent, l'intention est de présenter une nouvelle

méthodologie pour agréger les configurations spatiales du transport maritime à l'échelle mondiale à partir d'informations à micro-échelle sur le flux de biens maritimes.

L'objectif de notre article est d'évaluer les impacts des mutations du commerce international sur les activités portuaires chinoises à la lumière de quelques propositions clés : 1) les conditions du trafic contemporain ont nombre de conséquences sur le développement des infrastructures portuaires; 2) le Canada offre un excellent exemple d'avant-pays en transformation; 3) les politiques chinoises de développement portuaire ne doivent pas seulement se concentrer sur des facteurs internes mais aussi sur quelques facteurs externes, tels que les politiques régionales et les stratégies de développement des infrastructures de transport des pays partenaires commerciaux; 4) les conteneurs offrent un avant-pays plus continu, en étendant la zone d'influence des principaux ports d'une façon plus importante que ne le permet le transport des marchandises en vrac dont le parcours est plus simple.

Notre article cherchera à examiner comment les facteurs de localisation affectent les modèles d'interaction, ce qui résultera en une présentation méthodologique. Les aspects contemporains des ports chinois et canadiens seront ensuite examinés. Ceci sera suivi d'une analyse de l'impact sur le transport maritime de l'entrée de la Chine au marché économique mondial. Nous évaluerons ensuite l'avant-pays canadien des ports chinois. Nous conclurons par une analyse des implications possibles sur les politiques d'investissement, notamment dans le secteur des transports maritimes.

RELATION TERRITORIALE ET CONSIDÉRATION MÉTHODOLOGIQUE

Les facteurs persistants de localisation, de liens et d'accumulation qui caractérisent les ports, doivent être perçus en tant que système réflétant la réalité apparente d'un nouvel ordre économique.

Premièrement, toutes les localisations portuaires sont relatives. Il n'y a pas de ports qui soient isolés. Les ports sont importants ou non, centraux ou périphériques par rapport à d'autres ports. Les ports continuent d'exister ou de croître à condition qu'ils soient bien localisés en relation à d'autres ports et à d'autres infrastructures industrielles. Le succès d'une localisation dépend des liens à la fois avec l'arrière-pays et l'avant-pays.

Deuxièmement, tout changement survenant à un port affectera les ports qui lui sont reliés. L'impact dépendra du type de changement et du type de flux. Si une nouvelle route maritime était créée, l'importance des ports liés à cette route changerait. L'effet sur les ports s'étendra de positif à négatif en fonction du flux et de la distance.

Troisièmement, les ports sont des endroits fixes. Les facteurs territoriaux liés à l'influence de l'histoire, de la localisation des ressources, des densités de population, rendent les inégalités d'accès pratiquement inévitables. Dans ces conditions, le développement territorial non seulement contribue à la fixité des ports mais renforce les inégalités d'accès.

Un thème fréquemment analysé en géographie des transports est le rôle fondamental des ports de mer en tant qu'infrastructures de transport essentielles, conçues pour intégrer les réseaux de transport maritime et terrestre. Cette démarche nécessite toutefois une compréhension du concept d'interdépendance entre avant-pays et arrière-pays. Les ports reflètent les demandes faites sur leurs services de la part d'une grande variété d'acteurs situés dans l'arrière-pays et l'avant-pays. Une analyse des ports chinois dans le contexte du développement économique régional, requiert l'étude de l'interdépendance des débits portuaires et des caractéristiques de l'avant-pays des ports puisque le débit est fondamentalement fonction de la production et de la demande des avant-pays. Par ailleurs, la géographie économique des avant-pays fournit une explication partielle de la structure et du caractère du débit extérieur d'un port.

Suite à la contribution remarquable d'Alexandersson et Norstrom (1963), Berry (1966), Bird (1969), Yeates (1969), Charlier (1986), Van den Bremen (1986) et Hoare (1988), l'intention ici est d'explorer l'interdépendance entre la géographie des villes portuaires et la géographie des flux.

Le concept d'avant-pays est fondamental à la compréhension du développement rapide dans le secteur du transport maritime. Pour rendre le modèle aussi simple que possible, considérons :

Soit j un pays.

Soit i un avant-pays portuaire du pays j.

Soit T_{ij} une part du commerce maritime totale du pays j manutentionnée au port i.

Soit $P(i)$ l'ensemble des ports localisés dans le même pays que le port i.

Nous voulons déterminer dans quelle mesure la contribution d'un avant-pays portuaire à un arrière-pays se rapproche de la contribution de l'arrière-pays à un avant-pays portuaire.

Nous définissons $$FI = \sum_j \sum_i \left\{ \frac{T_{ij}}{\sum_i T_{ij}} \times \frac{\sum_{i \in P(i)} T_{ij}}{\sum_j T_{ij}} \right\} = 1$$

où l'indice d'avant pays (*FI*) exprime le rapport du débit d'un avant-pays portuaire entre l'arrière-pays et l'avant-pays au commerce maritime total de l'arrière-pays, multiplié par le rapport entre le commerce maritime total entre l'arrière-pays et l'avant-pays au débit total de l'avant-pays portuaire.

Au niveau régional, l'indice s'étend de 0 à 1. Idéalement, un tel coefficient devrait être calculé pour tous les arrière-pays et tous les avant-pays, ou pour tous les avant-pays d'un arrière-pays.

Une enquête sur tout le tonnage manutentionné aux ports canadiens dans la navigation maritime internationale, par port de manutention, par marchandise et par origine ou destination fut entreprise en 1987. Les données concernant le commerce maritime de la Chine furent clairement identifiées.

Dans l'équation, nous considérons *j* comme la Chine et *i* comme un port canadien. L'indice de l'avant-pays canadien de la Chine (F1) fut calculé à partir de :

1. la quantité totale de tonnes manutentionnées pour la Chine à chaque port canadien (T_{ij});

2. le commerce maritime total de la Chine $\sum_{i} T_{ij}$;

3. le commerce maritime total entre la Chine et le Canada $\sum_{i \in P(i)} T_{ij}$;

4. le débit portuaire total canadien $\sum_{j} T_{ij}$.

ASPECT CONTEMPORAINS DES PORTS CANADIENS ET CHINOIS

Depuis quelques années, l'internationalisation des échanges, notamment l'intégration économique nord-américaine avec la mise en place de l'Accord de libre-échange entre le Canada et les États-Unis a eu un impact sur la transformation des ports canadiens (Tessier et Dulude 1987). On observe un changement de stratégie dans la gestion des ports canadiens vers le développement de l'intermodalité et l'interconnexité. L'intermodalité demande un débit efficace et rapide des marchandises. Un port doit offrir à la fois des activités reliées à la production et un centre intégré de distribution. L'économie canadienne possède un faible potentiel pour le développement de son marché intérieur. Aussi l'objectif des firmes canadiennes consiste-t-il à établir d'importantes relations avec des économies étrangères. L'interconnexité territoriale qui en résulte exige quant à elle que l'interface intermodale aux points de rupture de charge, soit hautement intégrée à l'intérieur du système urbain nord américain. Les deux concepts déterminent le niveau de compétitivité des ports et indique l'importance de la capacité de manutentionner les conteneurs.

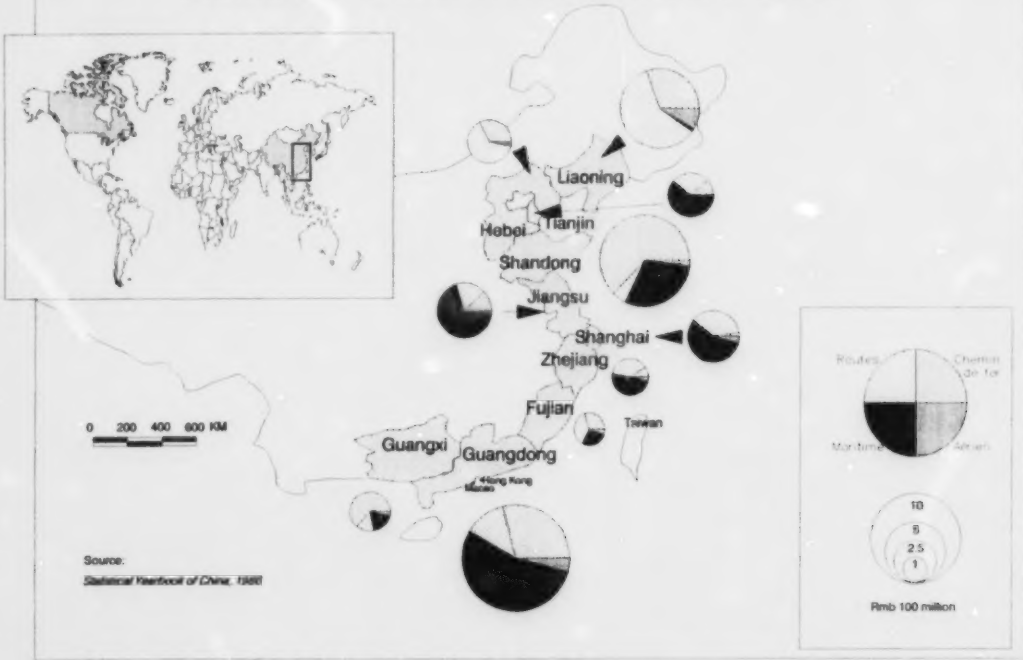
La manutention de conteneurs représente un changement majeur dans les opérations portuaires canadiennes. En 1986, le trafic international de conteneurs à Halifax, Montréal et Vancouver était de 82 pour cent, 82 pour cent et 39 pour cent respectivement (Bisson 1987). Ces chiffres indiquent que les ports de l'est du Canada s'adaptent plus rapidement au trafic de conteneurs que ceux situés à l'ouest. Deux explications peuvent être proposées. L'économie nord américaine se concentre essentiellement à l'est du continent mais, plus important encore, le système urbain côtier de l'est de l'Amérique du Nord est très bien intégré par le réseau ferroviaire. À titre d'exemple, un

chargement de conteneurs manutentionné à Montréal peut facilement être expédié vers nombre de points de destination en Amérique du Nord à travers le rail. Les perspectives économiques récentes du marché de l'Asie Pacifique tendent toutefois à accélérer le développement territorial de la côte ouest du continent. En effet, les ports de l'ouest du Canada atteindront bientôt leur pleine capacité puisqu'il est moins coûteux d'expédier du grain canadien, par exemple, des ports du Pacifique que de ceux de l'Atlantique (McCalla 1989). Face aux prévisions de production et de consommation de l'Asie-Pacifique, le besoin de conteneurisation et de changement majeur dans les infrastructures des transports routier, ferroviaire et maritime de la façade Pacifique du Canada est de plus en plus croissant.

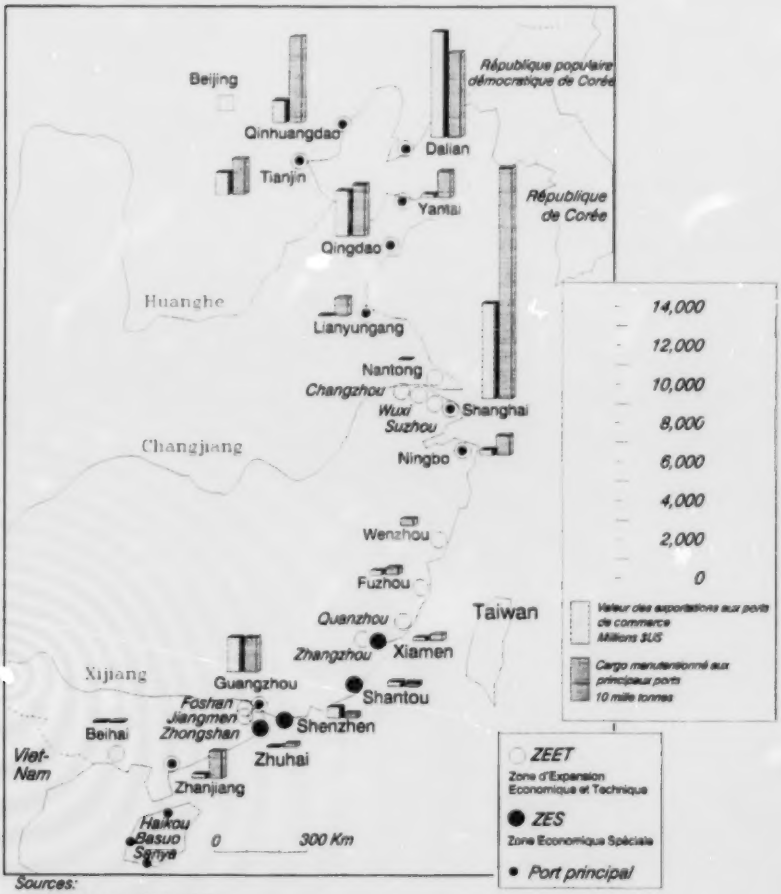
Le développement contemporain du marché économique mondial est constamment influencé par la participation croissante des nations de l'Asie de l'Est et du Sud-Est. La forte croissance du produit national brut et des besoins de consommation de ces pays, nécessite qu'une attention particulière soit apportée aux changements infrastructuraux dans la production régionale et les modes de distribution. Depuis 1978, l'évolution du système de transport de la Chine a été étroitement reliée à la modernisation des forces productives et des relations de production induites par l'instauration des réformes économiques (Leung et Comtois 1983). En effet, ces changements coïncident avec l'établissement de nouvelles politiques économiques et de gestion territoriale qui encouragent les échanges de biens, de personnes et de services (Croll 1988, Delfs 1986, Goldberg 1987, White 1987, Wong 1988). En conséquence, l'analyse du développement portuaire chinois et de l'évolution de l'avant-pays de la Chine doit considérer l'interrelation entre les politiques d'État concernant les investissements dans les transports, et les avantages économiques résultant de l'ouverture de la Chine au marché économique mondial.

Avec l'adoption du cinquième plan quinquennal (1976-1981), la Chine cherche à réintégrer le marché économique mondial dans le but d'accélérer la modernisation de sa production. De toute évidence, les bénéfices économiques et les connaissances technologiques résultant d'une participation croissante aux échanges mondiaux, doivent être appuyés par une accumulation adéquate du capital dans le secteur des transports. Une telle stratégie peut facilement être démontrée dans le développement du système portuaire chinois. En 1985, les investissements en capitaux dans les infrastructures de transport furent largement dominés par les trois provinces côtières de Liaoning (Rmb 815 000 000), Shandong (Rmb 1 006 000 000) et Guangdong (Rmb 1 542 000 000). La valeur des investissements reliés à l'établissement des zones économiques spéciales dans la province de Guangdong, liée à la localisation stratégique de cette province dans le système de transport du Bassin du Pacifique, peuvent expliquer la position privilégiée de Guangdong eu égard aux investissements en capitaux de l'État depuis 1978 (*Statistical Yearbook of China 1981*; *Statistical Yearbook of China 1988*).

Carte 1 Investissements en capital pour la construction dans le secteur des transports par mode pour les provinces côtières de Chine, 1985



Carte 2 Cargo manutentionné et valeur des exportations de quelques ports chinois, 1985.



Sources:
Statistical Yearbook of China, 1986
Wang et Bradbury, 1986

L'analyse de la distribution des investissements en capitaux dans le secteur des transports démontre que Guangdong possède la plus importante part des investissements en transport maritime (carte 1). En effet, la valeur des investissements de l'État pour le développement du secteur du transport maritime au Guangdong évaluée à Rmb 759 000 000, domine largement celui des autres provinces de Chine. Cette stratégie de planification territoriale non seulement reflète le besoin de développer les structures inhérentes du commerce international, mais marque également la volonté des autorités chinoises d'atteindre un développement territorial équilibré le long des régions côtières. En effet, la carte 2 révèle que les infrastructures portuaires des provinces du Nord-Est de la Chine prennent une part importante des bénéfices du commerce international. L'ensemble de la pénétration des devises étrangères en Chine se concentre au centre de la Chine, essentiellement à Shanghai qui est au cœur du système de transport maritime de la Chine.

Les provinces méridionales ont réorienté leur économies locales vers la promotion des industries légères (Pannel 1988, Rabushka 1987). Les réformes de planification territoriale en Chine, la proximité de Taïwan, le retour de Hong Kong à la Chine en 1997, de même que le développement de la division internationale du travail, ont favorisé cette récente tendance à l'industrialisation en Chine méridionale. Une tendance qui caractérise aussi les nouveaux pays industrialisés de l'Asie de l'Est et du Sud-Est (Maurer et Regnier 1989). L'impact de la croissance des opportunités économiques, suite à l'émergence d'une nouvelle configuration du commerce mondial, affecte le développement du système de transport des provinces côtières de Chine.

LA TRANSFORMATION DES FONCTIONS ET DU DÉVELOPPEMENT PORTUAIRE

L'intégration de l'économie de la Chine au marché a contribué à souligner le rôle prédominant du transport maritime dans les échanges internationaux. À titre d'exemple, les échanges de marchandises par voie maritime à l'intérieur du Bassin du Pacifique qui représentaient 11 pour cent du total mondial du transport maritime en 1972, ont atteint 19 pour cent en 1985. Les marchandises transportées hors Pacifique évaluées à 3 pour cent du transport maritime mondial en 1970, ont quant à elles atteint 6 pour cent en 1985. Il est important de souligner que les marchandises transportées vers la région du Pacifique demeurèrent constantes à 14 pour cent du total mondial pendant la même période. Par ailleurs, le transport maritime de marchandises dans les autres régions que celle du Pacifique est passé de 72 pour cent à 62 pour cent du total mondial pendant la période 1970-1985 (Van den Bremen 1988). Ces chiffres tendraient à démontrer la participation croissante de la Chine dans la circulation maritime mondiale des marchandises.

La croissance du trafic portuaire à travers les 15 principaux ports de Chine est résumé au tableau 1. La croissance dans le débit des ports depuis 1978 reflète l'ouverture économique de la Chine au commerce mondial. Le taux de croissance annuel moyen durant la période 1978-1987 est de 7,04 pour cent.

La plus forte croissance s'observe dans le commerce extérieur plutôt que dans le trafic domestique ou côtier. En effet, les données du tableau 1 révèlent que, bien que le taux de dépendance de l'économie chinoise au marché économique mondial soit faible, ce taux a plus que doublé durant la même période. Les ports chinois évoluent sous les pressions de nombre de facteurs affectant à la fois les relations entre les fonctons portuaires et la concurrence entre ports. Le développement des ports est influencé par des facteurs internes, externes et de localisation.

Tableau 1 Quelques indicateurs du commerce extérieur de la Chine

Année	Cargo manutentionné aux principaux ports (10 000 t)	Indice de dépendance %
1952	1 440	3,2
1957	3 727	3,3
1965	7 181	2,2
1978	19 834	2,6
1981	21 931	4,0
1982	23 764	3,9
1983	24 952	3,9
1984	27 549	4,6
1985	31 154	6,2
1986	34 409	6,8
1987	36 610	6,7

Note : L'indice de dépendance se définit comme la quantité totale de commerce extérieur divisée par le double du total du produit social.

Source : Statistical Yearbook of China 1984; *Statistical Yearbook of China 1986*; *Statistical Yearbook of China 1988*.

Les facteurs internes

L'agrandissement de l'espace maritime pour atteindre des avant-pays plus éloignés apparaît comme un élément stratégique de première importance. La part du transport international dans le volume global de transport croît avec le niveau de pénétration du commerce extérieur. Aussi, la Chine doit faire des choix eu égard à des infrastructures de transport à long terme qui soient d'intérêt chinois.

Tableau 2 Quelques indicateurs du transport océanique de la Chine

Année	Extrant/Travail	Extrant/Capital	Capital/Travail	Extrant/PNB
1965	77 320,6	62 368,4	1,240	,106
1970	106 631,0	55 866,7	1,909	,133
1975	333 439,6	43 490,1	7,667	,393
1980	537 138,9	44 596,0	12,045	,499
1985	722 889,9	51 051,1	14,160	,399
1987	830 693,2	48 759,7	17,036	,355

Note : Extrant se définit comme la quantité de fret tonne-kilomètre. Le travail est estimé à partir du nombre de personnel et de travailleurs dans les unités relevant de l'État dans le transport maritime et les services portuaires (0,82 pour cent du nombre total de personnel et de travailleurs dans les unités relevant de l'État). Le capital est le tonnage en jauge brute des navires océaniques marchands. Les données de 1985 et 1987 furent évaluées à 10 438 560 et 13 436 540 tonnes respectivement. Le PNB est la valeur des extrants bruts dans le domaine agricole et industriel.

Source : Comtois 1990; *Statistical Yearbook of China 1981*; *Statistical Yearbook of China 1984*; *Statistical Yearbook of China 1988*.

Le tableau 2 révèle quelques aspects de décision d'investissement et de production concernant le transport maritime de la Chine. Des gains constants en extrant/travail sont observés, alors que la mesure de l'extrant/capital indique un taux de décroissance annuel moyen de -3,54 pour cent entre 1965 et 1975, suivi d'une faible accélération du taux de croissance depuis 1975. Ces chiffres montrent que des changements de productivité sont survenus en Chine. De toute évidence, la productivité dans le domaine du transport océanique s'est accrue en Chine depuis 1965. Mais il est important d'établir une distinction très nette entre la productivité du travail et celle du capital. La marine marchande océanique de Chine a crû de façon spectaculaire depuis quelques années. En effet, il semble que des efforts majeurs ont été entrepris pour substituer le capital au travail. Le rapport/travail de 1987 est 13 fois supérieur à celui de 1965. Ceci tendrait à démontrer que même si la Chine a consenti d'importants investissements à améliorer ses équipements et ses techniques, la rapide croissance du commerce étranger a entraîné des pressions considérables sur le transport maritime chinois qui ne peut combler la demande croissante et qui doit ainsi se reposer sur les infrastructures portuaires qui sont plus intensives en main-d'œuvre. De plus, l'intensité du fret a décru depuis 1980. Ceci tendrait à démontrer que, alors que l'économie chinoise se diversifie, une plus faible proportion de produits lourds est transportée sur des navires océaniques, et suggère que des efforts importants ont été faits pour transformer les matières premières réduisant ainsi l'intensité du transport. Le charbon, le pétrole, le bois, le fer, et le cuivre qui sont transportés en grande

quantité sont l'objet de traitement avant le transport. Le processus de réduction du poids fait à la source des matières permet des économies de transport de plusieurs millions de tonnes par année. Ces chiffres indiquent également que la distance moyenne pour les navires océaniques s'est accrûe depuis 1965, réflétant le besoin de la Chine de commercer avec des partenaires de plus en plus lointains.

Les facteurs externes

Cette décennie a été marquée par l'introduction de nouvelles productions et une plus grande division de la production contrainte par le vieillissement des infrastructures industrielles et l'abandon de la technologie mécanique inerte et sa substitution par la robotisation. D'un point de vue géographique, une nouvelle structure territoriale émerge. Le développement portuaire dans les pays développés remet en cause les structures urbaines existantes. L'étendue et la vitesse du système de transport maritime, de même que la taille des investissements à réaliser, sont le reflet d'une réorganisation des régions dont la taille s'accroît sensiblement, établissant ainsi une nouvelle hiérarchie de centres urbains fondée sur la fusion des stations de transport, des échangeurs autoroutiers, des aéroports régionaux et internationaux, de même que des ports, en une agglomération économique régionale majeure. Les activités internationales sont présentées comme le complément nécessaire du trafic national. L'interdépendance des économies crée l'interdépendance des flux à travers les frontières politiques. La croissance du trafic international à l'intérieur et entre les blocs économiques régionaux s'accroît de façon significative. Face à la taille des investissements de transport à réaliser, les partenaires commerciaux considèrent la possibilité d'entreprendre des investissements de transport en tant que groupe plutôt qu'individuellement. La coopération entre pays apparaît donc une nécessité. De tel investissements de transport multinationaux sont bénéfiques à tous les ports participant, en plus de poursuivre la coopération économique, d'accroître l'intégration territoriale, et d'apporter des économies d'échelle valable.

Les facteurs de localisation

Les prévisions de demande de trafic océanique pour la Chine suggèrent une expansion continue des activités de transport maritime. Cette croissance dans la demande nécessitera de nouveaux véhicules de transport maritime, et de nouvelles techniques d'opération non seulement parce que les volumes s'accroîtront mais également parce qu'on note une évolution dans le type de cargo transporté. Toutefois, cette modification dans la nature du cargo n'affectera pas le besoin de pourvoir une infrastructure de transport maritime adéquate. Mais la nouvelle division internationale du travail reduira le poids relatif des ports chinois dans les activités de production de base et accroîtra leur participation dans le trafic de conteneurs, l'entreposage et les fonctions de distribution. La libéralisation des produits lourds et la réduction des coûts des produits finis donnent une grande flexibilité dans la localisation des

industries. Aussi les fonctions de distribution et commerciale sont-elles maintenant une priorité.

Les changements économiques annoncent la fin de la concentration des zones industrielles majeures héritées du passé. La taille de leur influence et la rigidité de leurs infrastructures imposèrent des contraintes qui ont isolé certains secteurs et favorisé un développement territorial inégal. Les autorités chinoises contemplent l'introduction d'industries de haute technologie le long des régions côtières. Mais la création de complexes portuaires majeurs dont l'accessibilité s'adapte progressivement aux besoins du système de transport maritime mondial, liée à l'établissement d'unités industrielles en amont menant vers des opérations majeures d'aménagement du territoire, est hautement douteuse. La poursuite de la construction du transport maritime chinois malgré ses difficultés et sa lenteur, doit considérer l'abolition de la rigidité des infrastructures portuaires qui empêchent le développement d'adaptations structurelles à long terme. En effet, le développement du système de télécommunications projettera une nouvelle forme spatiale qui redistribue les fonctions portuaires et réduit, à travers de meilleures communications, le besoin de mouvement physique des biens.

Ces facteurs ont mené vers : 1) un accroissement dans la nécessité d'améliorer les services de transport, 2) une augmentation des coûts des centres de distribution et 3) une réduction des coûts de transport sur une longue distance caractérisée par l'établissement de services de transport spécialiés, et marquée par une division de plus en plus nette dans la circulation des biens, des personnes et des services. Une meilleure compréhension peut être atteinte en examinant le commerce maritime sino-canadien.

LA DEMANDE DE TRANSPORT MARITIME ET LE COMMERCE SINO-CANADIEN

Parmi les changements récents qui ont influencé le commerce sino-canadien, soulignons :

- une internationalisation de l'économie chinoise telle que mesurée par une croissance de la part du commerce extérieur dans le produit national brut du pays;
- une régionalisation du commerce suite à 1) une participation accrue des pays en voie de développement dans le commerce de la Chine et suite au 2) Accord de libre-échange entre le Canada et les États-Unis;
- une croissance des coûts énergétiques qui affecte le nombre et la fréquence des ports d'attache;
- l'impact de la déréglementation des transports sur les transporteurs maritimes;
- l'accroissement de la quantité de tonnage conteneurisé.

Le cargo général représentait plus de 99 pour cent du commerce maritime Chine-Canada manutentionné, chargé et déchargé aux ports canadiens en 1987; alors que le mouvement de conteneurs en représentait à peine 1 pour

Tableau 3 Le commerce maritime sino-canadien aux ports du Canada, 1987

Produits	Entrées (tonnes)	Sorties (tonnes)
Nourriture et produits agricoles		
Animaux vivants		38
Produits végétaux		6 268 502
Huiles et graisses animales et végétales		3 976
Nourritures préparées	187	33
Minéraux et produits chimiques		
Produits minéraux	26 478	1 122 064
Produits chimiques	16 001	214 856
Plastiques		58
Produits forestiers		
Bois		345 893
Pulpe de bois, papier et carton		407 935
Textiles	15 334	147
Métaux et produits manufacturés		
Métaux et articles à base de métal	26 934	45 199
Machinerie et équipement	63	11 437
Equipement de transport		2 138
Articles manufacturés divers	33	1 694
TOTAL	85 030	8 423 970

Source: Statistiques Canada, 1989.

cent. Le tableau 3 révèle que la balance du commerce maritime bilatéral est massivement en faveur du Canada. En 1987, les exportations maritimes de la Chine vers le Canada excédaient à peine 1 pour cent des exportations canadiennes de marchandises vers la Chine. Le commerce avec la Chine représente approximativement 1 pour cent du commerce du Canada, alors que la part du commerce du Canada pour la Chine est plus importante à environ 5 pour cent. L'importante différence dans la structure des marchandises entre les importations et les exportations de cargo général entre le Canada et la Chine est un élément influençant la distribution portuaire des flux de cargo général. Un examen détaillé du commerce maritime est requis pour l'analyse de la demande de transport maritime et de services portuaires.

Les importations chinoises

La nourriture et les produits agricoles est le sous-groupe le plus important en poids dans les importations chinoises du Canada. Une part importante des exportations canadiennes courantes vers la Chine est composée de céréales. De toute évidence, le commerce sino-canadien ne s'est pas profondément modifié depuis deux décennies (Ho et Huenemann 1972). Le second groupe le plus important de marchandises comprend les minéraux, notamment la potasse qui représente une part prédominante des importations de la Chine pour son industrie de fertilisants chimiques. Enfin, il importe de souligner que les importations chinoises de bois et de dérivés de bois canadien demeurent importantes.

Les importations canadiennes

Les importations canadiennes en provenance de la Chine en 1987, ont été dominées par les produits minéraux, les biens manufacturés légers et les textiles. Le profil de marché des importations canadiennes de la Chine est essentiellement composé de cargo de faible valeur. La part de la demande pour des articles manufacturés dans le commerce maritime entre le Canada et la Chine sera directement affectée par les changements dans la distribution géographique de la production résultant de l'Accord de libre-échange entre le Canada et les États-Unis. Le transport maritime du cargo général chinois fera face à la concurrence de la part de : 1) une alternative dans le choix de modes de transport, 2) une nouvelle production de marchandises en Amérique du Nord, et 3) une redistribution de la cargaison entre ports.

La distribution géographique

La distribution géographique du commerce maritime fut fortement concentrée en 1987 à Prince Rupert et à Vancouver sur la côte ouest canadienne qui représentait 93 pour cent des tonnes de cargo manutentionné avec la Chine; alors que la part des ports de la côte est du Canada, principalement à Halifax et à Montréal, représentait à peine 7 pour cent. Le tableau 3. Les changements futurs dans les schémas de production démontreront probablement une concentration encore accrue de transport maritime à l'ouest du Canada. De meilleures explications peuvent être obtenues en identifiant les caractéristiques de localisation de chaque port. L'objectif n'est pas de prévoir les changements dans le commerce de la Chine à travers son niveau de dépendance envers l'avant-pays canadien mais plutôt de comprendre le profil de l'avant-pays.

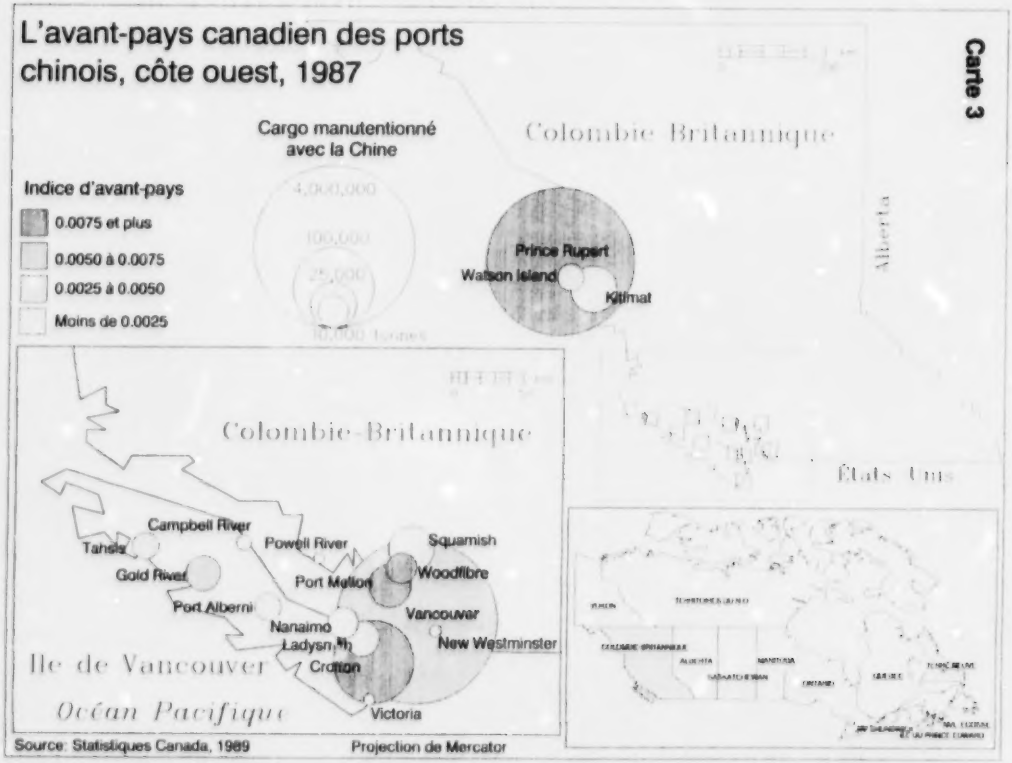
RÉSULTATS PRÉLIMINAIRES

L'avant-pays canadien de la Chine fournit un excellent exemple pour vérifier l'équation. Premièrement, le tableau 4 révèle que l'indice d'avant-pays de chaque port candien peut être clairement mesuré. La somme représente l'importance de l'avant-pays canadien à l'intérieur du commerce maritime total de l'avant-pays de la Chine. L'équation est un indice efficace qui donne une bonne valeur désagrégée pour chacun des ports canadiens.

Tableau 4 L'avant-pays canadien de la Chine, 1987.

Port	Localisation	Tonnes de cargo manutentionné	Tonnes de cargo manutentionné avec la Chine	Indice d'avant-pays
Prince Rupert	C.-B.	13 100 373	2 760 069	0,0198
Thorold	Ont.	261 423	28 912	0,0104
Port Mellon	C.-B.	189 805	20 929	0,0104
Crofton	C.-B.	930 481	90 435	0,0091
Woodfibre	C.-B.	141 393	12 401	0,0082
Corner Brooks	T.-N.	295 325	21 952	0,0070
Gold River	C.-B.	243 367	16 469	0,0064
Vancouver	C.-B.	60 280 333	3 980 318	0,0062
Ladysmith	C.-B.	286 532	13 877	0,0046
Valleyfield	Qué.	191 662	9 161	0,0045
Trois-Rivières	Qué.	1 331 687	56 567	0,0040
Tahsis	C.-B.	201 193	7 315	0,0034
Watson Island	C.-B.	247 040	7 928	0,0030
Squamish	C.-B.	953 126	25 920	0,0026
Botwood	T.-N.	334 008	8 620	0,0024
Port Alberni	C.-B.	668 933	10 581	0,0015
Kitimat	C.-B.	2 294 450	27 101	0,0011
Port Hawkesbury	N.-É.	1 803 624	20 640	0,0011
Toronto	Ont.	887 714	10 568	0,0011
Halifax	N.-É.	11 452 135	106 469	0,0009
Nanaimo	C.-B.	1 361 287	12 726	0,0009
Thunderbay	Ont.	3 476 862	27 272	0,0007
Baie Comeau	Qué.	3 125 536	24 424	0,0007
Montréal	Qué.	14 065 415	87 205	0,0006
Port Alfred	Qué.	3 061 439	16 001	0,0005
Campbell River	C.-B.	836 035	4 516	0,0005
Saint John	N.-B.	11 138 743	52 314	0,0004
Dalhousie	N.-B.	705 736	2 904	0,0004
Victoria	C.-B.	755 266	2 108	0,0003
Port Cartier	Qué.	18 436 881	37 571	0,0002
Powell River	C.-B.	300 352	600	0,0002
Sarnia	Ont.	3 647 038	3 247	0,0001
New Westminster	C.-B.	1 852 957	2 179	0,0001
TOTAL		158 858 151	7 509 299	0,1133

Source : Statistiques Canada, 1989.


L'avant-pays canadien des ports chinois, côte ouest, 1987
Carte 3
Cargo manutentionné avec la Chine
Indice d'avant-pays
0.0075 et plus
0.0050 à 0.0075
0.0025 à 0.0050
Moins de 0.0025
Colombie Britannique
Alberta
Prince Rupert
Watson Island
Kitimat
États Unis
Colombie-Britannique
Campbell River
Tahsis
Gold River
Powell River
Port Alberni
Port Mellon
Squamish
Woodfibre
Vancouver
Nanaimo
Ladysmith
Crofton
New Westminster
Victoria
Ile de Vancouver
Océan Pacifique
Source: Statistiques Canada, 1989
Projection de Mercator

Deuxièmement, comme prévu, plusieurs ports de la Colombie-Britannique sont groupés au plus haut niveau de l'indice. Les ports canadiens les plus importants obtiennent une marque élevée sur l'indice. Prince Rupert et Vancouver sont situés dans le premier quartile (carte 3).

Troisièmement, il semble y avoir une relation inverse entre la taille et le niveau d'avant-pays. En effet, plusieurs des ports canadiens qui ont un indice élevé manutentionnent moins de 1 million de tonnes par année (carte 4). Un examen de la composition des marchandises à chacun des ports révèle que les producteurs d'un seul type de marchandise ont intégré des services de transport maritime spécialisé.

STRATÉGIES D'INVESTISSEMENT

L'analyse concernant l'avant-pays canadien du commerce maritime de la Chine révèle l'importance des réajustements de transport canadien pour les investissements portuaires chinois. L'économie internationale a intégré la Chine dans le circuit de production et le commerce mondial. Toutefois, les ports ne sont pas des fins en soi mais plutôt des moyens à la disposition des économies nationales. Leur utilisation ouvre de remarquables possibilités; mais la décision de créer des zones de développement industriel maritime est le résultat de processus dont le contrôle s'exerce bien au-delà du secteur de transport maritime. La Chine n'a pas les infrastructures générales et majeures qui lui permettraient un redéveloppement suffisant des ports. Particulièrement sérieux est la lacune dans les investissements en conteneurisation, en intermodalité et en développement portuaire.

L'uniformisation du cargo général par la conteneurisation permet l'établissement d'un service porte-à-porte. La conteneurisation a entraîné de profondes transformations dans la structure du fret, et plusieurs ports chinois perdent leur avantage comparatif de site. Les ports de Chine se sont développés parce qu'ils occupaient une position clé sur la côte et plus particulièrement à l'embouchure de fleuves importants. La transformation croissante de l'économie de la Chine a stimulé la fonction de transit des ports de mer situés près des réseaux maritimes intérieurs qui possèdent les infrastructures nécessaires pour composer avec le trafic qui transite à travers les ports de mer. Shanghai est la plus importante ville portuaire de Chine. Les autorités chinoises cherchent à faire de Shanghai le plus important centre commercial et financier de la façade ouest du Pacifique (*Comprehensive Plan of Shanghai* s.d.). La plus importante route maritime entre l'Est et l'Ouest de la Chine est le Changjiang qui permet le trafic maritime en eaux profondes. L'introduction d'un service régulier de conteneurs pour le trafic maritime le long du Changjiang, liée à la participation croissante des provinces intérieures dans le marché économique mondial, non seulement affectera Shanghai, mais permet d'avancer qu'il n'existe pas de marchés garantis d'arrière-pays pour un port donné.

Carte 4

L'avant-pays canadien des ports chinois, côte est, 1987

Indice d'avant-pays

- 0.0075 et plus
- 0.0050 à 0.0075
- 0.0025 à 0.0050
- Moins de 0.0025

Ontario

Québec

Terre-Neuve

Thunder Bay

Port Cartier

Port Alfred

Baie Comeau

Botwood

Corner Brooks

Dalhousie

Nv. Brunswick

N.-Ecosse

Trois-Rivières

Valleyfield

Saint John

Port Hawkesbury

Montréal

Toronto

Sarnia

Thoroid

Halifax

Cargo manutentionné avec la Chine

100,000

25,000

10,000 tonnes

Source: Statistiques Canada, 1989

Projection de Mercator

Les autorités chinoises tentent de coordonner les investissements dans le transport ferroviaire, maritime et routier. Mais il existe nombre de difficultés à établir des critères pour l'évaluation des investissements relatifs à l'intermodalité. Le développement d'une chaîne de transport intermodal liant le rail, la route et la voie maritime a profondément modifié le rôle des modes de transports. Parallèlement aux autres modes de transport, les ports seront affectés par l'orientation vers le trafic combiné. Le mouvement des conteneurs va s'accroître. Si la qualité des ports et le potentiel de transport de fret déterminent la position d'un port sur les routes de transport maritime, alors les services et les moyens d'expédition doivent être efficaces. Ceci est particulièrement vrai dans le cas du transport routier dont la capacité à servir les ports doit être soulignée. À titre d'exemple, 72 pour cent du trafic de fret à Shanghai est d'ordre routier. La relation entre le transport routier et maritime fait face à plusieurs contraintes en Chine qui empêchent la coopération entre les deux modes de transport. Les contraintes sont essentiellement techniques, c'est-à-dire que des déficiences majeures sont observées dans l'expédition à cause de l'inadéquation des infrastructures routières. Les principaux ports de Chine devront être plus conteneurisés, de différentes dimensions et plus efficaces. L'efficacité d'un port dépendra étroitement du transport fluvial et terrestre de l'arrière-pays. Mais les routes continueront de jouer un rôle croissant. En effet, le choix d'expédition se fera de plus en plus au niveau de l'Asie-Pacifique. Les transporteurs maritimes devront définir à ce niveau une stratégie de regroupement pour la construction navale, les intermédiaires, les producteurs et les distributeurs. Cette évolution amènera les pays en bordure du Pacifique à s'organiser et à constituer des alliances dans le but de regrouper leurs intérêts. La Chine devra sérieusement considérer : 1) comment la gestion des flux entre les nœuds de circulation peut être déléguée, alors que les services de hautes valeurs ajoutées seraient situés à la convergence des points de rupture de charge et des nœuds de trafic, et 2) comment certains ports chinois peuvent être situés à la convergence des flux d'information et des zones de transformation des marchandises, alors que d'autres pourraient être des points de transit clé de flux d'importations et d'exportations entre le pays et le marché mondial. Ceci devrait amener les autorités chinoises à penser en termes de réseaux Asie-Pacifique, et même inter-continental, puisque ce sont les réseaux qui se développeront progressivement à l'aube du troisième millénaire.

Le problème de l'expansion des ports affecte particulièrement la Chine où les opérations sont jugées très importantes. Aussi il importe de savoir comment coordonner les investissements dans les infrastructures de transport et particulièrement dans les infrastructures portuaires. En Chine, les investissements pour améliorer les infrastructures de transport maritime ont été entrepris au niveau provincial. Pour servir efficacement le transport maritime de la Chine, chaque port ne peut opérer indépendamment. Le rôle de l'État concernant le développement portuaire à l'intérieur d'une économie planifiée est beaucoup plus direct, puisque l'État lui-même détient une position monopoliste en créant des fonds d'investissements et en contrôlant leur application. La concurrence qui existe entre les ports chinois et avec ceux de l'étranger

accroît les besoins en investissements portuaires notamment eu égard à l'entretien et au fonctionnement. Mais la taille des investissements de transport à réaliser présente des problèmes. Un point de départ possible serait de déterminer les investissements sur une base individuelle. Le nouveau fardeau qui pèse sur l'État chinois amènerait les autorités à repenser le financement des infrastructures portuaires. Il pourrait considérer accroître les responsabilités financières et le choix d'infrastructures dans les villes portuaires dans le cadre d'un processus de décentralisation. La Chine serait ainsi en mesure de prévoir les installations portuaires adaptées à la demande de trafic et le paiement des infrastructures en fonction de la compétitivité des industries locales.

La compétitivité des ports chinois sera étroitement liée à la présence d'équipements informatiques et à la qualité de formation du personnel. Les investissements immatériels en recherche et en développement, dans la formation et l'organisation de transport chinois, doivent porter le même poids que les investissements matériels. L'objectif est de faire un usage approprié et optimal des facilités existantes.

CONCLUSION

L'analyse des ports est justifiée face aux transformations territoriales de l'avant-pays de la Chine. Toute cette réalité pointe vers le besoin de flexibilité et d'adaptabilité aux changements. C'est une caractéristique qui peut être implantée dans des navires et des ports à fonctions multiples et dans l'organisation d'entreprises de commerce (Flemming 1978). Si la Chine doit transformer son économie et construire une capacité interne pour continuer une croissance soutenue, elle ne sera capable de l'accomplir qu'avec certaines restrictions. La mise en place d'une nouvelle infrastructure établira une nouvelle base qui ne sera pas nécessairement bénéfique face à la rapide transformation du globe. Face aux liens commerciaux maritimes de la Chine, l'étude de l'avant-pays canadien des ports chinois fait partie d'une entreprise qui mérite certes d'être approfondie.

RÉFÉRENCES

Alexandersson, G. et Norstrom, G. *World Shipping: an Economic Geography of Ports and Seaborne Trade*, London, Wiley, 1963.

Armstrong, W. et McGee, T. *Theatres of Accumulation: Studies in Asian and Latin American Urbanization*, London, Methuen, 1985.

Berry, B.J.L. *Essays on Commodity Flows and the Spatial Structure of the Indian Economy*. Research paper no. 111. Chicago, Department of Geography, University of Chicago, 1966.

Bird, J. «Ports Then and Later» dans *Ports et mers. Mélanges maritimistes offerts à André Vigarié*. J. Charlier (éd.) Caen, Paradigme, 1986, p. 157 à 170.

Bisson, G.B. «Les conteneurs : où en est-on?» *Portus*, vol. 2, n° 2, 1987, p. 40 à 41.

Charlier, J. (éd.). *Ports et mers. Mélanges maritimistes offerts à André Vigarié*, Caen, Paradigme, 1986.

Chen, Nairuenn. *Chinese Economic Statistics: a Handbook for Mainland China*, Chicago, Aldine, 1967.

_____ «An Assessment of Chinese Economic Data: Availability, Reliability, and Usability» dans U.S. Congress, Joint Economic Committee. *China: a Reassessment of the Economy*. Joint Committee Print, 94th Cong., 1st session Washington, D.C., Government Printing Office, 1975, p. 52 à 68.

Chieng, A. et Chang Chongyang. *Les nouvelles routes de la soie : l'art de commercer avec la Chine*, Paris, Economica, 1987.

China Statistics Monthly, mars 1989.

Comprehensive Plan of Shanghai. Shanghai : Bureau of Shanghai Urban Planning and Building Administration, s.d.

Comtois, Claude. «Transport and Territorial Development in China 1949-1985». *Modern Asian Studies*, vol. 24, n° 4, 1990, p. 777 à 818.

Croll, E. «The New Peasant Economy in China» dans *Transforming China's Economy in the Eighties*, S. Feutchwang, A. Hussain et T. Pairault, (éds.), vol. 1. Boulder, Westview Press, 1988, p. 77 à 99.

Delfs, R. «Discovered Drama in the Countryside». *Far Eastern Economic Review*, vol. 131, n° 12, 1986, p. 81 à 82.

Fleming, D.K. «A Concept of Flexibility». *Geojournal*, vol. 2, n° 2, 1978, p. 111 à 116.

Goldberg, M. *The Chinese Connection: Getting Plugged into the Pacific Rim Real Estate, Trade and Capital Market*, Vancouver, The University of British Columbia Press, 1985.

Haulman, C. «Financial Innovation and the Chinese Enterprise». *Journal of Northeast Asian Studies*, vol. 6, n° 2, 1987, p. 67 à 74.

Ho, S.P.S. et Huenemann, R.W. *Canada's Trade with China: Patterns and Prospects*, Montréal, The Canadian Economic Policy Committee of the Private Planning Association of Canada, 1972.

Hoare, A.G. «Geographical Aspects of British Overseas Trade: a Framework and a Review». *Environment and Planning A*, 20, 1988, p. 1345 à 1364.

Leung Chi-Keung. «Shipping and Port Development for Modernization» dans *Development and Change in China 2*, E.D.K. Chen et S.S.K. Chin, (éds.). Centre of Asian Studies Occasional Papers and Monographs, no. 46. Hong Kong, Centre of Asian Studies, University of Hong Kong, 1979, p. 127 à 143.

_____ et Comtois, C. «Transport Reorientation Towards the Eighties» in *China in Readjustment*, C.K. Leung et S.S.K. Chin, (éds.). Centre of Asian Studies Occasional Papers and Monographs, no. 54. Hong Kong, Centre of Asian Studies, University of Hong Kong, 1983, p. 216 à 233.

Li Chohming. *The Statistical System of Communist China*, Berkeley, University of California Press, 1962.

McCalla, R.J. «The Seaway: Rationale, Progress and Prospects». *The Operational Geographer*, vol. 7, n° 3, septembre 1989, p. 27 à 33.

Marcadon, J. «Le concept d'avant-pays marin : approche méthodologique» dans *Ports et mers. Mélanges maritimistes offers à André Vigarié*, J. Charlier, (éd.). Caen, Paradigme, 1986, p. 47 à 57.

_____ *L'avant-pays des ports français*, Paris, Masson, 1988.

Maurer, J.-L. et Regnier, P. (dir). *La nouvelle Asie industrielle : enjeux, stratégies et perspectives*, Paris, Presses Universitaires de France, 1989.

Monro, J.M. «Transport as a Bottleneck in Chinese Economic Development». Paper presented at the Fifth World Conference on Transport Research, Yokohama, Japan, du 10 à 14 juillet 1989.

Pannel, C.W. «Economic Reforms and Readjustment in the People's Republic of China and Some Geographical Consequences» dans *Comparative International Development*, vol. 22, n° 4, 1988, p. 55 à 73.

Rabushka, A. *The New China, Comparative Economic Development in Mainland China, Taiwan and Hong Kong*, Boulder, Westview Press, 1987.

Sletmo, G.K. et Holste, S. *China's Open Door and Shipping*. Centre de recherche sur les transports, Université de Montréal, Publication n° 617, mars 1989.

Stanley, W.R. «Some Geographic Trends in World Shipping». *Geojournal*, vol. 2, n° 2, 1978, p. 147 à 162.

Stromme Svendsen, A. «The Concentration of Capital in Shipping and Optimum Size of Shipping Companies». *Geojournal*, vol. 2, n° 2, 1978, p. 163 à 174.

Statistical Yearbook of China 1981. Hong Kong, Economic Information and Agency, 1981.

Statistical Yearbook of China 1982. Hong Kong, Economic Information and Agency, 1982.

Statistical Yearbook of China 1984. Hong Kong, Economic Information and Agency 1984.

Statistical Yearbook of China 1985. Hong Kong, Economic Information and Agency, 1985.

Statistical Yearbook of China 1986. Hong Kong, Economic Information and Agency, 1986.

Statistical Yearbook of China 1988. Hong Kong, Economic Information and Agency, 1988.

Statistiques Canada, Division Internationale. *Importations par Marchandises Décembre 1987*. Ottawa, ministère des Approvisionnements et Services, Canada, mars 1988.

Statistiques Canada, Division Internationale. *Exportations par Marchandises Décembre 1987*. Ottawa, ministère des Approvisionnements et Services, Canada, mars 1988.

Tessier, J.M. et Dulude, M. «Ces préoccupantes négociations du libre-échange». *Portus*, vol. 2, n° 1, 1987, p. 13, 15, 30.

Van den Bremen, W.J. «The Aggregate Spatial Patterns of Maritime Transport at World Scale: A Macro-scale Approach in Transport Geography». *Geojournal*, vol. 12, n° 3, 1986, p. 289 à 303.

Vigarié, A. *Échanges et transports internationaux*, Paris, Sirey, 1987.

Wang, Jici et Bradbury, J.D. «The Changing Industrial Geography of the Chinese Special Economic Zones». *Economic Geography*, vol. 62, n° 4, 1986, p. 307 à 320.

White, G. «The Impact of Economic Reforms in the Countryside: Towards the Politics of Social Capitalism». *Modern China*, vol. 13, n° 4, 1987, p. 411 à 440.

Wong, C.P.W. «Interpreting Rural Industrial Growth in the Post-Mao Period». *Modern China*, vol. 14, n° 1, 1988, p. 3 à 30.

Yeates, M.H. «A Note Concerning the Development of a Geographical Model of International Trade». *Geographical Analysis*, 1, 1969, p. 399 à 404.

ALEX MACLEOD*

Le Japon face à la montée du bloc commercial de la CEE : analyse des réactions et des stratégies†

Au cours de la seconde moitié des années 80, le Japon pouvait croire que ses plus mauvais cauchemars commerciaux étaient sur le point de se réaliser. Lui, qui avait axé de plus en plus son développement économique sur l'extérieur du pays, voyait deux de ses marchés les plus importants prendre des mesures qui risquaient de rendre leur accès plus difficile à ses produits. D'un côté, les États-Unis et le Canada se dirigeaient vers une entente de libre-échange, et de l'autre, la Communauté économique européenne déclarait son intention, dans un livre blanc publié en juin 1985, de former enfin un marché unique où toutes les entraves encore existantes entre les pays membres auraient disparu à la fin de 1992.

Dans le cas de l'Amérique du Nord, le Japon pouvait espérer continuer ses négociations traditionnelles, malgré un durcissement à son égard de la part de l'administration et encore plus du Congrès, car le nombre de joueurs était limité. En plus, il jouissait d'une relation politique privilégiée avec les États-Unis, et connaissait des rapports assez cordiaux avec le Canada. Par contre, les relations entre le Japon et la CEE reposaient presque uniquement sur le commerce et depuis quelques années traversaient une période assez tendue. Dans cette nouvelle situation où le protectionnisme menaçait des positions commerciales durement acquises, le Japon se devait de revoir ses stratégies s'il ne voulait pas se voir interdire l'entrée dans le marché le plus important du monde. C'est la recherche de ces stratégies de rechange qui fera l'objet principal de cette communication, mais il serait utile de rappeler d'abord les éléments du contentieux qui pèse depuis les années 60 sur les relations entre le Japon et le Marché commun européen.

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LES RELATIONS ENTRE LE JAPON ET LA CEE

Pendant les premières années consécutives à la seconde guerre mondiale, les pays européens cherchaient surtout à interdire l'accès aux produits japonais, considérés de piètre qualité et trop bon marché. Même quand le Japon, appuyé par les États-Unis, demanda d'adhérer au GATT (General Agreement on Tariffs and Trade), organisation vouée à la libération du commerce international, en 1955, la Grande-Bretagne et la plupart des autres pays ouest-européens acceptèrent seulement à condition qu'ils ne fussent pas obligés de lui accorder le statut de nation la plus favorisée. Ils maintinrent cette position jusqu'en 1964 quand le Japon devint membre de l'Organisation pour la Coopération et le Développement Économique et accéda enfin au club des pays industrialisés à part entière. Toutefois plusieurs pays européens continuèrent à garder des restrictions sur les importations japonaises. Malgré ce handicap, le Japon parvint à rattraper et puis à dépasser les Européens dans des domaines vitaux de leur économie, tels que la sidérurgie, la construction navale, les appareils ménagers, l'électronique et, bien sûr, l'automobile. Grâce à sa stratégie industrielle, le Japon avait réussi à lancer un défi à l'Europe sur son propre terrain.

En 1968, le commerce entre le Japon et la CEE connut son premier excédent en faveur du premier. Ainsi commença une histoire de déficits commerciaux entre les deux partenaires qui ne cessa pas de croître jusqu'en 1989[1]. Au cours des années 70 des représentants des deux côtés se réunirent plusieurs fois sans jamais remédier à cette situation et sans faire d'entente commerciale significative.

Une mission du *Keidanren*, principale organisation patronale du Japon, venue à Bruxelles en octobre 1976, apprit de première main le degré de frustration ressentie par les Européens à l'égard du Japon et comprit qu'un état de guerre commerciale appréhendée existait entre le Japon et la CEE. Cette visite déclencha une véritable campagne anti-japonaise dans la presse européenne. Mais malgré cette pression, les Japonais et les Européens se montrèrent toujours incapables de s'entendre sur des solutions à long terme. Tout au plus, ils signèrent des accords sur des limitations volontaires des exportations du Japon et quelques mesures destinées à ouvrir le marché japonais, sans signification notable. La récession qui suivit le deuxième «choc pétrolier» de 1979 et la montée du protectionnisme aux États-Unis forcèrent les Européens à chercher de nouvelles solutions sur le plan commercial.

Depuis 1982, la CEE tente de mettre sur pied une politique commune face au Japon, mais les positions divergentes des pays membres rendent un tel exercice très difficile. Non seulement il y a des différences importantes dans les relations de chaque pays avec le Japon, mais aussi les idéologies commerciales les séparent. La Grande-Bretagne et l'Allemagne fédérale soutiennent une politique de libre-échange face au monde extérieur, tandis que la France et l'Italie favorisent une politique beaucoup plus protectionniste. Les deux premières ont connu un certain succès dans leurs tentatives de percer le marché japonais de l'automobile depuis 1981, surtout la RFA, que vend plus de 80 %

des voitures étrangères écoulées au Japon, mais les deux autres se sentent très vulnérables à la concurrence japonaise en Europe et nourrissent peu d'espoir de trouver des compensations sur le marché japonais.

Mais au-delà du problème de la coordination de douze politiques commerciales au sein de la CEE, les structures de prise de décision dans la Communauté européenne et au Japon ajoutent aux difficultés d'arriver à des ententes à long terme entre les deux partenaires. À la CEE, la division des tâches entre la Commission, qui propose des politiques et qui les exécute, le Conseil des ministres, qui formule et ratifie les politiques, et le Conseil européen, réunissant les chefs de gouvernement, et qui décide des grandes lignes de la politique de la CEE, sans parler des pays individuels et du rôle du Parlement européen[2], ne facilite pas les négociations pour un pays habitué à traiter avec des entités diplomatiques traditionnelles. Et que dire du Japon et des rivalités entre les ministères de l'Industrie et du Commerce international (MITI[3]), des Finances et des Affaires étrangères, du rôle prépondérant joué par le Parti libéral démocrate (PLD), au pouvoir depuis 1955 et lui-même divisé actuellement entre cinq factions rivales bien organisées, de l'importance croissante des *zoku* (tribus), de véritables porte-paroles des groupes d'intérêt au sein de l'aile parlementaire du PLD, et bien sûr des liens étroits entre les ministères, le gouvernement et le PLD et les groupes de pression les plus puissants au pays[4]? Il est vrai que depuis les années 70, les Japonais et les Européens ont institutionnalisé leurs relations à travers une série de rencontres au niveau de la direction de la Commission de la CEE et des ministres pertinents au Japon. Mais même si de telles consultations sont «considérées indispensables pour éviter l'irruption d'une guerre commerciale»[5], on ne peut pas dire qu'elles ont débouché sur des ententes d'envergure satisfaisantes pour les deux parties. D'ailleurs la situation politique interne du Japon mit fin temporairement aux consultations ministérielles en décembre 1986[6], privant ainsi le Japon d'un forum de négociation au moment même où la CEE entreprenait les mesures préparatoires au marché unique de 1992.

Le déséquilibre commercial en faveur du Japon demeure le point le plus litigieux entre la CEE et le Japon. Sans atteindre les proportions du déficit américain, qui représente plus que le double de celui de l'Europe mais pour un niveau de commerce beaucoup plus élevé (voir le tableau 1), ce déséquilibre est considéré alarmant et est devenu pour les Européens la pierre de touche de l'état de leurs relations avec le Japon. En fait, la CEE ne se fait guère d'illusion sur sa capacité de réduire de façon significative ce déficit, du moins à court terme, mais il sert d'outil de négociation face aux Japonais en forçant ces derniers à faire des concessions sur un pont où des progrès visibles sont rares. À la différence des Américains, les Européens jouissent d'un excédent global sur le plan du commerce extérieur. Ils veulent surtout s'assurer que leurs produits auront un accès équitable au marché interne japonais.

Tableau 1 : Les relations commerciales entre le Japon et les États-Unis et entre le Japon et la CEE en 1989 (en milliards US $)

	Importations	Exportations	Déficit
États-Unis	93.188	48.246	44.942
CEE	47.908	28.146	19.762

Source : Statistiques douanières du Japon

Le cas des vins et des spiritueux européens sur le marché japonais est souvent cité comme l'exemple type d'une politique japonaise où le Japon semble respecter des principes généraux pour mieux protéger un produit japonais contre un produit étranger supérieur. En plus, il s'agit d'un bien important dans les exportations européennes, surtout pour la France et la Grande-Bretagne. Tout simplement le Japon produit son propre «scotch» à partir du whisky écossais importé en vrac. En instituant un système de graduation qui plaçait le whisky écossais dans une catégorie spéciale, les Japonais soumettaient la boisson écossaise à une taxe sept fois plus élevée que celle qui s'appliquait au scotch ordinaire japonais et deux fois plus que celle payée sur celui de la meilleure qualité. Par contre, le tarif levé sur le whisky japonais entrant en Grande-Bretagne était sept fois moins élevé que celui qui s'appliquait au produit britannique entrant au Japon[7]. Après avoir tenté en vain d'arriver à une entente acceptable, la CEE décida de renvoyer l'affaire devant un comité du GATT dans l'espoir de faire condamner le Japon pour pratiques déloyales. Le GATT donna raison à la Communauté européenne. Les Européens devaient vite déchanter, car les Japonais, tout en acceptant de se conformer à la décision de l'organisation internationale, annoncèrent que le cas des spiritueux serait inclus dans la révision générale du système de fiscalité indirecte prévue seulement seize mois plus tard[8]. C'est alors seulement que la CEE pouvait enfin considérer l'affaire close.

Cet exemple illustre bien la plainte principale des Européens contre les Japonais. Ces derniers ne respecteraient pas les règles du commerce international. En particulier, le marché japonais, en dépit des apparences d'ouverture, resterait largement inaccessible aux produits européens. Mais en même temps, les Japonais pratiqueraient une forme de «dumping» qui défie toute concurrence. L'exemple des spiritueux semble confirmer cette impression de protectionnisme déguisé. Les Japonais répliquent, non sans raison, que leur marché contient bien moins de tarifs et de quotas que celui de la plupart des pays de la CEE[9]. Chiffres à l'appui, ils sont capables de démontrer que les Européens vendent de plus en plus de produits au Japon[10]. Ils concluent donc que, si ces derniers veulent vraiment réduire le déficit commercial, ils n'ont qu'à faire un plus grand effort pour pénétrer le marché japonais. La Commission elle-même

a reconnu que les relations CEE-Japon étaient «encore sous-développées» et cela en partie à cause de la «négligence européenne»[11].

Pour contrer les effets des importations japonaises, les Européens ont surtout recours à des armes juridiques et législatives[12]. Parmi les plus utilisées de ces armes, on peut citer les appels au GATT, comme dans le cas des spiritueux, et plus récemment l'adoption d'une législation antidumping très stricte et toute une réglementation sur les notions de contenu local et de règles d'origine. C'est dans ce contexte que le Japon se voit obligé de formuler une stratégie qui lui permettra de garder la place qu'il s'est déjà taillée.

LE JAPON FACE À L'EUROPE DE 1992

Les hommes d'affaires japonais expriment un certain scepticisme quant à la capacité réelle des Européens de réaliser le marché unique pour 1992. Cela ne les empêche pas de conseiller fortement à leurs compatriotes de prendre au sérieux la menace d'un marché beaucoup plus difficile à pénétrer[13]. Le discours officiel, pour sa part, se réjouit de «l'émergence d'une communauté forte, unifiée et ouverte qui répond résolument aux changements structurels dans l'économie mondiale en allant de l'avant avec des ajustements structurels à l'économie européenne»[14]. Mais derrière ces déclarations se cachent des craintes de voir la CEE se fermer de plus en plus aux produits japonais. Cette peur s'exprime surtout chez les manufacturiers, tandis que les milieux financiers affichent un optimisme prudent, malgré des demandes européennes pour une ouverture plus grande du marché japonais dans le domaine des services financiers.

En réalité, comme l'affirma la revue britannique *The Economist*, le Japon vit déjà à l'époque de la «Forteresse Europe», car la CEE a mis en place une série d'obstacles d'apparence neutre qui visent spécialement la concurrence japonaise[15]. Avec l'adoption de sa réglementation sur le dumping en 1987, la CEE rend très difficile toute compétition extérieure basée sur les prix[16]. Les règles sur le dumping s'étendent aux produits fabriqués par des entreprises japonaises établies dans d'autres pays, surtout aux États-Unis, et même celles qui se trouvent dans les pays membres de la CEE. On vise en fait les usines dites de tournevis où l'on fait essentiellement l'assemblage à partir de pièces importées du Japon. Pour contrer cette pratique, la CEE a émis des directives contraignantes sur le contenu local et l'origine qui exigent un minimum de 60 pour cent de fabrication locale pour qu'un produit puisse être considéré comme européen. Avec ces armes, la CEE s'est attaquée aux importations japonaises de machines à écrire électroniques et de semiconducteurs, et même aux importations de copieuses de la compagnie Ricoh faites en Californie, en prétendant qu'elles n'étaient pas vraiment américaines. Dans le cas des semiconducteurs, la Commission changea les termes de sa réglementation en substituant la notion de l'opération la «plus substantielle» pour celle du «dernier processus substantiel» qui s'applique normalement, dans le but évident d'obliger les Japonais à transférer plus de technologie vers l'Europe[17]. Cette tactique a remporté un certain succès, puisque des compagnies

japonaises, et non les moindres, se sont engagées à acheter plus de pièces locales en échange d'une exemption des tarifs antidumping[18].

Les plus grandes craintes des Japonais à l'égard de la nouvelle Europe se résument en un seul mot : réciprocité. C'est la Commission elle-même qui entretient les appréhensions japonaises à ce sujet quand elle précise ce que l'Europe attend de ses partenaires commerciaux dans des termes comme ceux-ci :

> Dans l'attente de la mise en œuvre des accords multilatéraux en cours de négociation, il serait toutefois présumé pour la Communauté — dans des domaines qui ne font pas encore l'objet d'obligations internationales — d'étendre automatiquement et unilatéralement aux pays tiers les avantages des progrès réalisés sur le plan interne dans la voie de la libération. Les pays tiers, dont on peut raisonnablement attendre des mesures de libération comparables, en tireront profit dans la mesure où un équilibre des avantages mutuels est assuré dans l'esprit du GATT.[19]

Cette conception de la réciprocité vise clairement les Japonais, qui la contestent au nom de l'équité et du réalisme. Si on l'appliquait à la lettre, cette forme de réciprocité, selon un représentant du gouvernement de Tokyo, «réduirait très sérieusement les limites du libre-échange et conduirait à l'opposé de ce que nous devrions réaliser»[20]. Les Japonais savent fort bien qu'avec une définition aussi large de la réciprocité, la CEE pourrait toujours trouver une raison pour exclure un produit japonais ou du moins avoir en main un bon instrument pour forcer les négociations dans un sens qui lui est favorable.

L'industrie de l'automobile est devenue pour les Japonais le cas d'espèce qui démontrera la vraie nature du futur marché unique. Pour le moment, les voitures japonaises sont soumises à des régimes de barrières nationales très variés. Ainsi, elles peuvent rentrer librement sur le marché ouest-allemand, tandis que les Italiens invoquent une entente des années 50 pour limiter leur importation à environ 3 000 par année. Les Français ne leur accordent que 3 pour cent du marché annuellement et les Britanniques leur laissent une part du marché de 11 pour cent. La-dessus se greffe le problème des voitures construites par les Japonais dans des usines européennes, sans parler de celles fabriquées aux États-Unis.

Les Japonais posent une question très simple : quelle sera la politique commune de la CEE à l'égard de leurs automobiles après 1992 ? Les gestes posés par certains pays, notamment la France, les déclarations publiques des uns et des autres et la tournure du débat à l'intérieur des instances communautaires n'ont rien de rassurant pour les Japonais. Pour comprendre les difficultés d'un règlement de la question qui satisferait les Japonais, il faut voir les tendances de l'industrie de l'automobile et de la vente des voitures dans la CEE. On prévoit qu'entre 1988 et 1995 la part des constructeurs européens du marché passera de 83,3 pour cent à 74,4 pour cent et celle des voitures japonaises (incluant les autos fabriquées en Europe et aux États-Unis) passerait de 11,3 pour cent à 17,8 pour cent. Et certains croient que les Japonais

prendraient jusqu'à 20 pour cent du marché européen[21]. Par ailleurs, quand on se souvient que l'industrie de l'automobile représente environ 10 pour cent du produit intérieur brut et 10 pour cent des effectifs salariés de la CEE[22], on se rend compte de l'ampleur des enjeux en cause.

Un indice de l'âpreté de la bataille que doivent livrer les Japonais pour avoir accès au marché unique est venu de l'affaire entourant les voitures Bluebird faites par la compagnie Nissan dans ses usines britanniques. Les Japonais et les Britanniques prétendaient que ces voitures recontraient les exigences de la CEE d'un contenu local de 60 pour cent. Les Français, en s'appuyant sur les revendications du Comité des constructeurs du Marché commun, exigeaient qu'elle contiennent un contenu local d'au moins 80 pour cent, sinon ils continueraient à les comptabiliser dans leur quota de 3 pour cent. En plus, plusieurs constructeurs européens accusèrent les Japonais et les Britanniques de gonfler les chiffres qui auraient indiqué un contenu local réel de 50 pour cent. Finalement, en décembre 1988, les Anglais obtinrent de la Commission une décision condamnant les Français pour avoir imposé une norme supérieure à celle décrétée par la Communauté. Quatre mois plus tard, la France et la Grande-Bretagne s'entendirent pour ne plus compter les voitures Nissan construites en Grande-Bretagne dans le quota des 3 pour cent. L'Italie accepta de façon informelle un accord semblable. En 1990, les pays de la CEE refusèrent d'accepter des voitures Honda construites aux États-Unis comme des voitures américaines. Cette fois-ci, le gouvernement américain s'est vu forcé de défendre la position japonaise, malgré son propre contentieux avec le Japon sur la question des automobiles.

Le débat au sein de la CEE n'est pas encore résolu et les hésitations à formuler une politique commune sur ce sujet semblent donner raison au scepticisme des Japonais à propos de la capacité des Européens de mettre en place un véritable marché unique, le 1er janvier 1993. La Commission tend vers un système de limitations volontaires de la part des Japonais mais plusieurs constructeurs européens favorisent un gel des importations des voitures japonaises autour des 9,5 pour cent de la part du marché de la CEE qu'elles représentent actuellement. Les pays partisans du libre-échange accepteraient que les Japonais prennent jusqu'à 20 pour cent. Tous semblent d'accord pour dire que toute limitation doit être provisoire et qu'il doit y avoir une période transitoire afin de permettre aux constructeurs européens de devenir plus compétitifs face aux Japonais[23].

Traditionnellement, les Japonais ont répondu de façon réactive, c'est-à-dire en se contentant de réagir aux initiatives des autres, dans la formulation de leur politique de commerce international[24]. Il s'agissait d'éviter coûte que coûte une confrontation directe dont les Japonais ne pouvaient jamais sortir gagnants. Chaque fois que la CEE a érigé une barrière commerciale, le Japon a tenté d'y répondre, ou bien en s'y conformant formellement ou bien en négociant une entente qui rencontrait les objections de ses adversaires. L'acceptation des limitations volontaires, l'augmentation du contenu local, la création d'usines sur place ont toutes été utilisées pour calmer la colère des Européens. En plus, le Japon a souvent exploité des rivalités entre les pays

membres pour négocier des accords séparés. La perspective d'un marché vraiment unifié et rationalisé mettra fin à de telles pratiques, ou du moins obligera les Japonais d'y apporter des ajustements.

Les Japonais semblent décidés à faire face directement au défi de l'Europe de 1992. Ils rejettent donc l'alternative de la création d'un bloc asiatique ou d'une association des pays du Pacifique[25]. Cela leur permet de se présenter comme les défenseurs incontestables du libre-échange. Mais surtout les compagnies japonaises semblent décides à s'«européaniser», à devenir des «insiders»[26]. Cela signifie qu'elles vont augmenter leurs investissements directs et mettre en place des filiales au lieu de créer des industries indépendantes. De cette façon, les entreprises japonaises seront mieux armées pour affronter les géants de l'industrie européenne.

Pour se mesurer aux grandes entreprises européennes, les Japonais misent aussi sur les «joint ventures» avec des partenaires conscients de la complémentarité qui peut exister entre firmes japonaises et européennes. L'exemple le plus spectaculaire de ce genre de coopération, qui permettra aux intéressés de devenir de véritables «insiders», est celui du pacte entre les deux plus grands conglomérats japonais et ouest-allemands, Mitsubishi et Daimler-Benz[27]. L'entreprise européenne a annoncé clairement les avantages qu'elle croit pourvoir tirer de cette collaboration qui lui donnera accès non seulement à l'expertise technologique de son partenaire nippon mais aussi à ses réseaux de distribution en Asie[28], tandis que Mitsubishi espère que cette alliance «détendra les frictions commerciales entre le Japon et la Communauté européenne»[29]. Il n'est donc pas étonnant que le MITI ait donné son appui à cette entente.

De telles initiatives ne font pas nécessairement le bonheur de tous les Européens. La Commission elle-même a exprimé ses réticences devant les dangers de voir les pays et les régions européens se concurrencer pour offrir les meilleures conditions aux investisseurs japonais[30]. Le ministre français des Affaires européennes, Edith Cresson, parla même de la création d'usines d'automobiles japonaises en Europe comme faisant partie d'une stratégie de la part des Japonais visant à «établir des entreprises au Japon, en Europe et en Amérique là où ils le peuvent et à changer de production pour qu'ils puissent détruire les constructeurs d'automobiles américains et européens»[31]. Des déclarations de ce genre, qui frisent l'hystérie, font partie de la «Japanophobie» que craignent tant les dirigeants politiques et les hommes d'affaires japonais et qu'ils voient naître, malgré une image relativement positive dans la population générale[32].

Un aspect de la stratégie de faire de plus grands investissements directs en Europe était déjà visible avant 1989. Il prend maintenant un certain relief à la lumière des événements qui ont secoué l'Europe de l'Est en 1989 et en 1990 : c'est la décision de se concentrer de plus en plus sur l'Allemagne. Dans le passé, les Japonais ont choisi d'abord la Grande-Bretagne comme lieu d'investissement, à cause de la langue, à cause de l'importance de Londres comme centre financier et à cause du climat social et économique propice que leur promettait la politique du gouvernement Thatcher. Mais la République

fédérale d'Allemagne a aussi attiré beaucoup d'investisseurs japonais dans le passé. Une enquête auprès de 130 entreprises japonaises en 1988 révéla déjà une nette préférence pour la RFA dans leurs projets d'investissements[33]. Devant la perspective d'une Allemagne unifiée, les financiers et les industriels japonais parlent de plus en plus de leur intention de déménager leur siège social européen en Allemagne pour se trouver au cœur du marché géant européen de l'avenir et qui comprendra aussi un jour les pays de l'Association européenne de libre-échange[34].

Les préparatifs en vue de 1992 ont obligé le Japon à changer un élément important de sa politique commerciale. Il a abandonné ses réactions traditionnelles pour une politique plus ouvertement agressive en décidant, en octobre 1988, pour la première fois de son histoire, de poursuivre un partenaire commercial, en l'occurrence la CEE, en vertu du paragraphe 2 de l'article 23 de GATT; et cela pour protester contre les mesures antidumping prises par Bruxelles contre ses produits électroniques que les Européens avaient pénalisés comme étant de simples assemblages faits dans des usines dites de tournevis. Dix-huit mois plus tard, un comité du GATT donna raison au Japon. Les observateurs s'entendent pour dire que cette décision ne changera pas nécessairement la politique antidumping de la CEE, mais elle force cette dernière à revoir son règlement et son application[35].

CONCLUSION

S'il est vrai que le déficit commercial de la CEE vis-à-vis du Japon est en train de diminuer depuis 1989, surtout à cause de la croissance des exportations européennes vers le Japon, on peut douter que ce phénomène ne change plus que marginalement les relations entre la CEE et le Japon. On ne doit jamais oublier que leurs rapports sont essentiellement de nature purement commerciale et ne peuvent compter sur la force médiatrice de relations politiques ou de défense, comme dans le cas des liens entre le Japon et les États-Unis. En outre, leurs économies se concurrencent sur le plan international. Ils exportent l'un vers l'autre des produits manufacturés et rivalisent dans le domaine des matières premières, à la différence de la complémentarité, même boiteuse, du commerce entre le Japon et les pays nord-américains.

Le contentieux entre le Japon et la CEE est donc d'ordre structurel; les tentatives des Européens de contrôler les importations japonaises ont échoué misérablement. Au contraire, la perspective d'une «Forteresse Europe» a stimulé les Japonais avec des résultats qui semblent contraires à ceux que la CEE avait souhaités. À cet égard on peut citer l'exemple de la législation sur le dumping. Bien que les Européens prétendent que cette réglementation a obligé les Japonais à augmenter le contenu local des produits fabriqués en Europe, on ne peut s'empêcher de penser qu'elle a surtout poussé les Japonais à changer leur stratégie d'investissements d'une façon qui ne semble pas plaire à tous les Européens. Les Japonais sont maintenant en meilleure posture que jamais pour affronter l'échéance de 1992.

NOTES

1. En 1968 la CEE accusa un déficit de 99 millions US $. En 1988 le déficit atteignit presque 23 milliards US $.
2. Sur le fonctionnement des institutions de la CEE, voir Marie Françoise Labouz, *Le système communautaire européen*, Berger-Levraut, Paris, 1988, deuxième édition, p. 167 à 212.
3. Ce ministère est surtout connu sous les initiales de son nom en anglais, Ministry of International Trade and Industry.
4. Sur la formulation de la politique commerciale au Japon, voir Chikara Higashi, *Japanese Trade Policy Formulation*, Praeger, New York, 1983, p. 33 à 60.
5. Jacques Pelkmans, «Economic Relations Between the European Community and East Asia: Protectionism or Cooperation?», Philip West et Frans A.M. Altung (sous la direction de), *The Pacific Rim and the Western World Strategic, Economic, and Cultural Perspectives*, Westview Press, Boulder et Londres, 1987, p. 221.
6. Takehiko Nishiyama (Ambassadeur du Japon auprès de la CEE), «Adieu Forteresse Europe? — Inquiétudes actuelles : un point de vue japonais», *À l'écoute du Japon*, le 17 avril 1990, p. 2.
7. «EEC joins Britain in test case over whisky tax», *The Times*, le 30 mars 1987.
8. Voir la déclaration de l'Ambassadeur de la CEE au Japon, dans Hisane Masaki, «EC pleased with domestic expansion here, but wants more», *The Japan Times*, le 22 décembre 1988 et celle de la Commission de la CEE, *Europe* (bulletin officieux de la CEE), le 9 avril 1988, p. 9.
9. Pour une analyse critique des plaintes européennes contre le Japon, voir Gerard et Victoria Curzon, «Follies in European Trade Relations with Japan» *The World Economy*, 10:2, juin 1987, p. 164-170. On retrouvera un résumé de la position officielle de la CEE à l'égard du marché japonais dans un document préparé par les services de la Commission, «L'état actuel des relations entre la CEE et le Japon», *Europe-Documents*, le 11 juin 1988, p. 1 à 6.
10. Depuis 1989 le bulletin bimensuel de l'ambassade du Japon auprès de la CEE, *À l'écoute du Japon*, publie régulièrement, avec une satisfaction manifeste, des chiffres confirmant la baisse du déficit commercial entre la CEE et le Japon en mettant l'accent sur la montée des importations européennes au Japon.
11. «Communication de la Commission au Conseil», *Europe-Documents*, le 25 février 1986, p. 1.
12. Pour une synthèse de ces outils, voir Lucien R. Le Lièvre et Luc G. Houben, «EC versus Japan: the Community's Legal Weapons», *Common Market Law Review*, 24:3, automne 1987, p. 427 à 455.

13. Voir par exemple les entrevues avec des hommes d'affaires de Koichi Hori, «Getting Ready for Europe 1992», *Economic Eye*, décembre 1988, p. 28 à 32.
14. Hideaki Kumano (directeur général du MITI), «Japan and the EC Should Join Hands», *European Affairs*, 2, été 1988, p. 117.
15. «Set up or stay out», *The Economist*, le 18 février 1989, p. 52.
16. Pour une analyse critique de la mécanique et du but de cette législation, voir «A gun that needs to get knotted», *The Economist*, le 9 septembre 1989, p. 82 à 83.
17. «Set up or stay out», *loc. cit.* et Shada Islam, «Brussels digs in», *Far Eastern Economic Review*, le 23 février 1989, p. 74.
18. «Talks sought on new EC trade law», *The Japan Times*, le 28 juillet 1988.
19. «L'achèvement du marché intérieur : un espace sans frontières intérieures. Rapport sur l'état des travaux requis par l'article 8B du traité», le 17 novembre 1988, COM(88) 650 final, p. 9.
20. Michihiko Kunihiro (ministre adjoint des Affaires étrangères), «The External Implications of the Single European Market: A View from Japan», conférence prononcée devant le Royal Institute of International Affairs, Londres, le 11 octobre 1988 (ronéotypée), p. 7.
21. Pour toutes ces prévisions, voir «Ready, steady....», *The Economist*, le 23 septembre 1989, p. 79.
22. Eric Le Boucher, «L'automobile européenne face aux ambitions nipponnes», *Le Monde*, le 21 mars 1989.
23. «EC seeks voluntary restraints against Japanese auto-makers», *The Globe and Mail*, le 1er janvier 1990.
24. Kent Calder, «Japanese Foreign Economic Policy: Explaining the Reactive State», *World Politics*, vol. 40, n° 1, 1988, p. 517 à 541.
25. Anthony Rowley, «One rule for all», *Far Eastern Economic Review*, le 8 juin 1989, p. 67.
26. Ian Rodgers, «Japanese strive to become good Europeans», *Financial Times*, le 20 juin 1988; et Hiroe Ikemura, «Market integration promises gains, but rules have yet to be worked out», *The Japan Times*, le 8 novembre 1988.
27. Pour les détails de cette entente, voir David E. Sanger, «Daimler-Benz and Mitsubishi Negotiating Cooperative Plan», *The New York Times*, le 7 mars 1990 et Charles Smith, «Two's company», *Far Eastern Economic Review*, le 24 mai 1990, p. 67.
28. Ferdinand Protzman, «Approach of 1992 Provides a Sense of Urgency», *The New York Times*, le 7 mars 1990.
29. David E. Sanger. *loc. cit.*
30. «Relations entre la Communauté et le Japon : récents développements», le 15 mars 1988, COM(88) 136 final — II, p. 2.
31. David E. Sanger, *loc. cit.*

32. Selon un sondage du ministère des Affaires extérieures du Japon auprès des habitants de sept pays de la CEE (dont la France), fait au printemps 1989, *À l'écoute du Japon*, le 17 juillet 1989, p. 1 à 3.
33. Karl-Rudolf Korte, «Japan and the Single European Market», *Aussenpolitik*, vol. 40, n° 4, 1989, p. 404 à 405.
34. Akihiro Tamiya, «Japan's investment poised for a shift to unified Germany», *The Globe and Mail*, le 19 avril 1990 (article publié antérieurement dans *The Japan Economic Journal*).
35. Shada Islam, «Brussels rout», *Far Eastern Economic Review*, le 12 avril 1990, p. 48.

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La modernisation de la Chine dans le miroir de l'histoire: continuités et ruptures†

En dépit du sentiment irréductible d'absurdité, d'impuissance, de désespoir même, que nous avons éprouvé face aux événements de la place Tiananmen, le recul du temps, ce grand sauveur, nous permet en ce premier anniversaire, de replacer cette tragédie dans un contexte plus large et de la comprendre comme un nouveau chapitre dans la longue lutte de la Chine pour sa modernisation. La notion de «modernisation» a remplacé celle de «révolution» dans la problématique de la Chine contemporaine (Bergère 1987, p. 223) : c'est là le postulat principal de cet exposé. Il comportera trois parties : 1) une revue des éléments qui constituent l'événement de la place Tiananmen; 2) les efforts de la Chine pour se moderniser depuis le milieu du XIX[e] siècle; 3) les continuités et les ruptures dans la tradition politique chinoise qui, aujourd'hui, font obstacle à la modernisation.

TIANANMEN : ACTION ET RÉACTION[1]

L'événement de la place Tiananmen ne se limite pas aux péripéties qui se sont déroulées dans la nuit du samedi 3 juin au dimanche 4 juin 1989, ce que la presse internationale a appelé le «massacre de la place Tiananmen»; il englobe aussi les antécédents et les causes, les protagonistes en présence, ainsi que les séquelles de l'événement en Chine et à l'étranger.

Les antécédents immédiats

Dans la nuit du 4 juin 1989, l'Armée du peuple, appuyée par des blindés, fit irruption sur la place Tiananmen de Beijing et ouvrit le feu sur des milliers de citoyens chinois, la plupart des étudiants universitaires. Les manifestations pro-démocratiques, lancées au lendemain de la mort de Hu Yaobang, ancien secrétaire général du Parti communiste chinois, le 17 avril, durèrent plus de

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six semaines et connurent plusieurs moments de paroxysme, notamment la commémoration du 70e anniversaire du 4 mai 1919, la visite de M. Gorbatchev du 15 au 18 mai, et le décret de la loi martiale par le premier ministre Li Peng le 19 mai. C'est le refus des manifestants d'obtempérer à la loi martiale qui justifia techniquement l'utilisation de l'armée pour réprimer l'occupation de la place Tiananmen par les manifestants. Les estimés les plus autorisés font état de plus de 1 000 tués et de 6 000 blessés dans la nuit du 4 juin 1989.

Les participants

Les organisateurs et les leaders du mouvement de protestation furent majoritairement des étudiants des universités de la ville de Beijing. Il y eut aussi un nombre considérable de jeunes sans travail. Mais la masse des manifestants et des sympathisants provenaient de tous les secteurs de la société, sans qu'il y eut cependant de véritable coalition entre ces divers groupes, comme ont voulu le laisser entendre, pour des raisons fort différentes, certains médias de la Chine et de l'Occident. Le décret entourant les décisions et actions gouvernementales rend difficiles l'identification et le rôle des acteurs du côté du pouvoir. De l'avis des spécialistes, trois points se dégagent : 1) les décisions furent prises et entérinées par les plus hautes instances du Parti et de l'État; 2) le processus décisionnel entraîna de vives oppositions entre diverses factions au sein du gouvernement et de l'armée; 3) la faction conservatrice, soutenue par certains généraux, prévalut sur la faction plus libérale.

Les revendications

Il ne semble pas que les leaders des manifestations eussent de programme bien défini. Lors des deux rencontres des représentants des étudiants avec les autorités chinoises, les demandes furent plutôt générales : enrayer la corruption (népotisme, vénalité, opportunisme) chez les cadres du gouvernement et du Parti, réformer les institutions politiques (fin de la domination du Parti), accorder au peuple une plus grande liberté d'expression et le droit de critiquer le gouvernement, libéraliser l'économie. Dans certains cas, on exigea même la démission des plus hautes instances du gouvernement chinois.

Les causes

On peut identifier trois ordres de causes :

1) sur le plan socio-économique, les inégalités engendrées par la réforme; la réforme de l'agriculture (1980-1985) favorisa la prospérité des régions rurales avoisinant les grandes agglomérations urbaines, alors que l'arrière-pays stagnait ou même s'appauvrissait; quant à la réforme urbaine (1985-), elle permit aux villes des régions côtières de connaître un développement spectaculaire, souvent au détriment des villes de l'intérieur;
2) sur le plan politique, l'autocratisme d'un régime qui se veut au-dessus de la loi, qui se considère indispensable et irremplaçable, et qui demande la loyauté au pouvoir plutôt qu'au peuple;

3) sur le plan international, l'influence des modèles et des valeurs occidentales, diffusée en Chine par la presse, les médias électroniques et par les étudiants qui reviennent de longs séjours à l'étranger.

Les conséquences

1) à l'intérieur, la répression sous plusieurs formes : chasse aux manifestants et incarcération et, dans certains cas, exécution (le contrôle s'exerce surtout par le truchement des unités d'appartenance, *danwei*); invitation à la délation; désinformation et endoctrinement; réduction du nombre des admissions dans les universités et des étudiants envoyés à l'étranger;
2) à l'extérieur, protestation officielle des organismes internationaux (ONU, Greenpeace) et de plusieurs gouvernements occidentaux; départ obligatoire des ressortissants étrangers vivant en Chine à la demande de leurs gouvernements repectifs; rappel des ambassadeurs pour consultation; suspension de l'aide internationale; suspension de nombreux méga-projets conjoints; suspension des missions de niveau ministériel par les pays occidentaux; prolongation indéfinie des visas pour les étudiants chinois à l'étranger.

   Les pays occidentaux ont unanimement condamné le Gouvernement chinois pour la brutalité avec laquelle il avait écrasé des manifestations pacifiques par des citoyens aux mains nues. La Chine s'est justifiée en niant l'ampleur du massacre, en présentant les manifestants comme des rebelles contre-révolutionnaires, en invoquant la raison d'État et en déclarant l'événement une affaire «interne».

ESSAI D'INTERPRÉTATION : OMBRES DANS UN MIROIR TERNI

Crise de modernisation

Tiananmen semble avant tout refléter un nouvel éclatement dans le processus de modernisation de la Chine. Ce mouvement, né au milieu du XIX^{e} siécle, n'a toujours pas atteint ses objectifs (Bergère 1987, p. 181s.; Fairbank 1989, p. 475s.). Parmi les facteurs défavorables à la modernisation, nous nous arrêterons surtout au caractère autocratique du gouvernement chinois et au fossé qui existe entre les intellectuels et les cadres politiques. L'importance accordée aux politiques correspond bien à l'opinion des spécialistes occidentaux de la Chine contemporaine, qui reconnaissent que la crise présente du gouvernement chinois s'enracine dans l'absence ou la faillite de la réforme politique, qui aurait dû accompagner les réformes socio-économiques modernisantes initiées par Deng Xiaoping en 1979 (Chevrier, in Aubert *et al.*, 1986, p. 288s.)

Aspects de la modernisation

L'expression «modernisation» pose un problème dans la mesure où ce mot désigne d'abord et avant tout un phénomène caractéristique des sociétés

occidentales et, récemment, du Japon : la modernité (Baudrillard 1978, p. 139 à 141). Il s'agit d'un concept complexe qui s'enracine dans une rupture de la «tradition» européenne à partir du XV[e] siècle avec la découverte du «nouveau monde», la redécouverte de l'Antiquité gréco-romaine et l'invention de l'imprimerie. On peut en suivre les étapes : les fondements d'une approche scientifique avec Galilée, la querelle des Anciens et des Modernes, la Réforme protestante et le Concile de Trente, le siècle des Lumières et la Révolution française, les révolutions industrielle, technologique et informationnelle des XIX[e] et XX[e] siècles. Sous l'impact de ces révolutions, l'Occident (et plus récemment le Japon) a été profondément transformé sous ses aspects économiques, politiques, sociologiques et tout aussi bien dans son système de valeurs et de croyances. La «modernisation» est un processus qui, comme le voulait Max Weber (1971), mène à la modernité par une rationalisation de l'ensemble des activités d'une société. On peut voir la difficulté de transposer ce concept dans une société et dans une civilisation aussi différentes des pays occidentaux dans sa structure, son histoire et ses valeurs que peut l'être la Chine. Bien souvent, lorsqu'ils parlent des «quatre modernisations», les Chinois s'en tiennent à certains côtés bien définis de la modernité occidentale, touchant surtout aux sciences appliquées, à la technologie de production et de gestion, sans toujours se rendre compte qu'il est impossible de moderniser à la pièce (Chin 1979, p. 37s. et 243s.; Rozman 1981, p. 7s.). Il faut insister sur le caractère «organique» de la modernité et de la modernisation. Même lorsque la modernisation est acceptée globalement par des pays non occidentaux, comme ce semble être le cas pour le Japon, elle prend, en raison des traditions initiales, des configurations bien différentes du modèle occidental. La tradition autochtone, comme l'illustre encore le Japon, peut même devenir un atout considérable pour l'extension de la modernisation à des domaines inédits.

Une chose est certaine : on ne peut plus désormais identifier la modernisation à l'occidentalisation ni à l'industrialisation. Il est sans doute utilile de clarifier certaines notions. On a souvent assimilé «modernisation» et «développement». Les deux idées ne se recoupent qu'en partie. Par exemple, on ne peut nier que la Chine, au cours de sa longue histoire, n'ait progressé d'une façon parfois spectaculaire. Comme l'a montré l'historien des sciences Jospeh Needham, la Chine, au XVII[e] siècle, était, sur le plan technologique, plus avancée que l'Occident. Et pourtant, on ne peut dire que ces progrès dans plusieurs domaines de l'activité humaine aient mené la Chine à la modernité entendue au sens occidental du mot.

Les débuts de la modernisation en Chine

C'est à son corps défendant, sous l'impact de la puissance militaire supérieure des pays occidentaux, que la Chine se résigna à la modernisation. Jusque-là, la Chine s'était considérée comme le pays le plus évolué et le plus puissant de la planète. S'il devait y avoir modernisation, c'était plutôt du côté de l'Occident. Mais au lendemain de ses défaites successives aux mains des Anglais, puis des forces anglo-françaises, lors des guerres de l'opium (1839-1842 et 1856-1860), la Chine impériale, confrontée à la menace d'une invasion

de son territoire par les puissances coloniales européennes, se rendit à la dure évidence de la nécessité impérieuse de se «moderniser». La défaite navale de la Chine par le Japon — qui s'était lancé dans un programme accéléré de modernisation dans la foulée de la Réforme de Meiji en 1868 — à Shimonoseki en 1895 emporta les dernières résistances (Jansen 1975, p. 25 à 29). Se moderniser oui, mais comment et à quel prix ? Dès les débuts, les intellectuels chinois furent conscients du caractère global et insidieux de la modernisation. L'un de leurs principaux représentants, Zhang Zhidong (1837-1909), trouva la formule qui sembla pallier les craintes de la majorité : «adopter les techniques occidentales (les «fonctions secondaires», *yong*) comme moyen pour renforcer l'armée et rendre le pays prospère et ainsi préserver les valeurs nationales (la «substance», *ti*)» (Teng et Fairbank 1954, p. 164s.).

On commença par l'acquisition d'armements occidentaux; puis à mettre sur pied des arsenaux où se feraient la mise au point et la réparation de ces équipements et où on formerait des techniciens à cet effet; puis des écoles spécialisées à l'occidentale qui formeraient des étudiants capables de devenir des techniciens qualifiés; puis un système d'éducation modelé sur l'Occident, qui donnerait une formation générale en sciences et en mathématiques; puis une structure sociale qui favoriserait un tel système d'éducation, avec les transformations politiques et économiques correspondantes. Bon gré mal gré, on se rendit compte que les «techniques occidentales» étaient inséparables d'une «substance occidentale» (Chih 1972). En 1898, l'ancien système d'éducation, basé sur les classiques chinois et sur les examens impériaux, fut aboli; en 1905, les premières écoles et universités de type occidental firent leur apparition; en 1911, la dynastie impériale des Qing fut renversée et remplacée par une république parlementaire basée sur le modèle européen. Les premiers modernistes chinois commencèrent par être des nationalistes, puis des réformistes et au bout de la ligne des révolutionnaires qui demeurèrent toujours nationalistes. Ce n'est que dans la mouvance des événements du 4 mai 1919, que les révolutionnaires chinois, outragés par ce qu'ils perçurent comme une trahison de l'Occident lors du Traité de Versailles, entreprirent de troquer la «substance» chinoise contre le marxisme-léninisme et la révolution socialiste (Vandermeersch 1986, p. 152 à 153).

Après la victoire du Parti communiste en 1949, la révolution socialiste, qui avait radicalement transformé les structures sociales, politiques et économiques, s'attaqua, sous l'égide de la Révolution culturelle (1966-1976), aux valeurs et aux croyances traditionnelles, ce qu'on appela les «valeurs féodales de la Chine».

On ne peut nier que, durant cette longue période qui va du renversement de l'empire à l'ère contemporaine des réformes, la Chine ne se soit modernisée, si l'on entend par là la «rationalisation» des activités de la société chinoise. Mais c'est une modernisation basée sur un modèle artificiel et étroit, qui s'est révélée insuffisante pour répondre aux objectifs que la Chine s'était fixés au tournant du siècle et plus récemment, en 1968, lorsque Zhou Enlai (1896-1976) proclama le programme des Quatres Modernisations : atteindre à la fin du

siècle un niveau de développement comparable aux pays industrialisés dans le domaine de l'agriculture, de l'industrie, de la science et de la technologie, et de la défense nationale.

Quelques facteurs inhibiteurs de la modernisation

Dans d'autres circonstances, nous aurions pu nous pencher sur certaines caractéristiques de la société chinoise qui favorisent la modernisation. Car il est indéniable que depuis le tournant du siècle, et tout particulièrement depuis l'avènement du régime communiste en 1949, la Chine a réalisé des progrès considérables sur la voie de la modernisation. Il suffit de penser que depuis 1975, le taux de croissance du PNB a été en moyenne de 4,5 pour cent, l'un des plus élevés au monde, même parmi les nations industrialisées (Vandermeersch 1986, p. 24s.). Mais à la lumière des événements de la place Tiananmen, il est aussi péremptoire que la modernisation de la Chine est en butte à des obstacles non seulement conjecturels, mais structurels. C'est à deux de ces facteurs négatifs, inhibiteurs, que je veux m'arrêter dans cette dernière partie de mon exposé, soit l'autocratisme politique et la scission entre le gouvernement et les intellectuels. De ces deux facteurs, le premier est en continuité et le second, en rupture avec la tradition chinoise.

De toutes les attitudes politiques traditionnelles, celle qui semble avoir survécu avec le plus de vigueur est, selon Fairbank (1989, p. I-IV), «l'autocratisme du gouvernement chinois». Nous avons déjà vu plus haut les traits principaux de cette sorte de primauté absolue que la tradition a toujours accordée au processus politique et à l'appareil politique en Chine. Si la Chine ne connut pas le conflit du sacré et du profane comme tant d'autres sociétés traditionnelles, c'est sans doute que le pouvoir et la raison politique y enveloppèrent indistinctement les fonctions séculières et sacerdotales, conférant à l'acte gouvernemental une plénitude de sens sans appel. Ce fut là une embûche continuelle à la modernisation dans la mesure où celle-ci relativise et soumet à la crititque la sphère politique tout entière. L'autocratisme politique chinois trouve ses racines profondes dans la conception du sage de l'Antiquité, qui règne par un mandat et une puissance bienfaisante émanant tous deux du Ciel. Avec la fondation de l'empire en -221, les empereurs dynastiques récupérèrent cette prérogative absolutiste, qui faisait de leur lignée une suite de despotes tout-puissants (Balazs 1968, p. 25-32). À chaque dynastie, la même idéologie était réaffirmée. On sait que peu après la fondation de la première république, on assista à une tentative presque réussie par Yuan Shikai (1859-1916) de rétablir un pouvoir monarchique et même impérial en Chine. Lorsqu'enfin Mao Zedong (1893-1976) émergea comme le chef indisputé de la Chine nouvelle, il instaura un pouvoir personnel et collectif qui, en bien des points, rappelait le style des empereurs d'antan. La dissémination du «Petit livre rouge» et l'érection des innombrables statues du Grand Timonier pendant la Révolution culturelle, revêtit Mao d'un prestige dont bien peu d'empereurs eussent osé s'affubler, malgré leur majesté impériale. Il ne s'agit pas tant d'une question de gloire personnelle que d'une structure mentale profondément enfouie dans l'histoire socio-politique de la

Chine ancienne et dont la Chine nouvelle, à travers toutes ses révolutions, ne semble pas parvenir à se défaire.

Comme l'a montré Balazs (1968, p. 32-40), durant toute l'histoire dynastique, le pouvoir impérial s'appuya sur la classe des lettrés. Ceux-ci formèrent la véritable ossature du système politique chinois, l'empereur faisant figure de chef paradigmatique de cette aristocratie du savoir-faire. «L'originalité de la Chine», dira Balazs (1968, p. 32), «consiste à avoir créé une forme de régime monocratique où la bureaucratie civile des fonctionnaires-lettrés, en tant que groupe social, domine nettement l'État». Cette symbiose entre les lettrés, c'est-à-dire, les intellectuels, et le pouvoir politique, fut brisée avec l'avènement du gouvernement communiste en Chine. On connait, en effet, à partir des années 50, à tous les échelons de la fonction publique, la prédominance non pas exclusive, il est vrai, mais tendancieuse, du critère politique («rouge») sur le critère de compétence («expert»). Cette rupture a exclu d'une participation active au développement et à la modernisation du pays une bonne part de la couche la plus productive de la société et a favorisé une forme de loyauté au Parti et à l'État qui découragerait l'initiative et l'innovation, ingrédients essentiels de la modernisation, et favorisait le conformisme bureaucratique, ennemi du changement, même progressif.

NOTES

1. Les renseignements sur les événements de la place Tiananmen sont tirés de la presse internationale entre le 15 avril et le 15 juin 1989 et des ouvrages de synthèse de Simmie et Nixon (1989), Salisbury (1989), et Ching (1990).

BIBLIOGRAPHIE

Aubert, Claude *et al. La Société chinoise après Mao. Entre autorité et modernité*, Paris, Fayard, 1986, 339 p.

Balazs, Étienne. *La bureaucratie céleste. Recherche sur l'économie et la société de la Chine traditionnelle*, Paris, Gallimard, 1968, 346 p.

Baudrillard, Jean. «Modernité», dans *Encyclopaedia Universalis*, vol. 11, 1978, p. 139 à 141.

Billeter, J.-F., G. Étienne et J.-L. Maurer. *Sociétés asiatiques : mutations et continuité*, Paris, Presse universitaires de France, 1985, 107 p.

Bergère, Marie-Claire. *L'Age d'or de la bourgeoisie chinoise, 1911-1937*, Paris, Flammarion, 1986, 370 p.

_____. *La République populaire de Chine de 1949 à nos jours*, Paris, Armand Colin, 1987, 283 p.

_____, Lucien Bianco et Jürgen Domes, (éds.). *La Chine au XX^e siècle. D'une révolution à l'autre (1895-1949)*, Paris, Fayard, 1989, 441 p.

Buxbaum, David C. et Frederick W. Mote, (éds.). *Transition and Permanence: Chinese History and Culture. A Festschrift in Honor of Dr. Hsiao Kung-ch'üan*, Hong Kong, Cathay Press, 1972, 433 p.

Chang Chih-tung [Zhang Zhidong]. *China's Only Hope. An Appeal*, trad. du chinois par Samuel I. Woodbridge. New York, Chicago, Toronto et Londres, Fleming H. Revell, 1900, 151 p.

Chang, Hao. *Chinese Intellectuals in Crisis. Search for Order and Meaning (1890-1911)*, Berkeley, Los Angeles et Londres, University of California Press, 1987, 223 p.

Chesneaux, Jean et Marianne Bastid. *Histoire de la Chine 1 : des guerres de l'opium à la guerre franco-chinoise 1840/1885*, Paris, Hatier Université, 1969, 224 p.

Chih, André. *L'Occident «chrétien» vu par les Chinois vers la fin du XIX^e siècle (1870-1900)*, Paris, 1962, 273 p.

Chin, Steve S.K. *Modernization in China*. Hong Kong, University of Hong Kong (Centre of Asian Studies), 1979, 309 p.

Ching, Julia. *Probing China's Soul. Religion, Politics, and Protest in the People's Republic*, New York, HarperCollins, 1990.

Domenach, Jean-Luc. «Chine : le retour au modèle classique (1979-1982)», *Encyclopaedia Universalis* (*Universalia* 1983), p. 126 à 133.

Fairbank, John K. *La grande Révolution chinoise 1800-1989*, trad. de l'américain, Paris, Flammarion, 1989, 548 p.

Gaudu, Agnès. *Chine, l'empire déchiré*, Paris, Editions Ramsay, 1989, 273 p.

Gernet, Jacques. *Chine et christianisme, action et réaction*, Paris, Gallimard, 1982, 342 p.

Jansen, Marius B. *Japan and China: from War to Peace, 1894-1972*, Chicago, Rand McNally, 1975, 547 p.

Nash, M. «Modernization: cultural meanings — the widening gap between the intellectuals and the process», *Economic Development and Cultural Change*, 25 (1977 : supplément), p. 16 à 28.

Moore, W.E. «Modernization as rationalization: processes and restraints», *Economic Development and Cultural Change*, 25 (1977 : supplément), p. 29 à 42.

Rozman, Gilbert, (éd.). *The Modernization of China*, New York et Londres, The Free Press, 1981, 551 p.

Salisbury, Harrison S. *Tiananmen Diary: Thirteen Days in June*, Boston, Little Brown, 1989, 176 p.

Schwartz, Benjamin. «The Limits of Tradition versus Modernity as Categories of Explanation: The Case of Chinese Intellectuals», *Daedalus* (printemps 1972), p. 71 à 88.

Simmie, Scott, et Bob Nixon. *Tiananmen Square*, Vancouver/Toronto, Douglas & McIntyre, 1989, 206 p.

Smith, Richard. *China's Cultural Heritage: The Ch'ing Dynasty, 1644-1912*, Boulder, Colorado, Westview Press et Londres, Francis Pinter (Publishers), 1983, 321 p.

Su Wenming, (éd.). *Modernization — the Chinese Way*, Beijing, Beijing Review, 1983, 175 p.

Teng Ssu-yü et John K. Fairbank. *China's Response to the West. A Documentary Survey 1839-1923*, Cambridge, Harvard University Press, 1954, 296 p.

Tsai, Frank Wen-hui. *Essays on the Study of Chinese Modernization* (Asian Folklore & Social Life Monographs, vol. 92), Taipei, The Orient Cultural Service, 1979, 167 p.

Vandermeersch, Léon. *Le nouveau Monde sinisé*, Paris, Presses universitaires de France, 1986, 224 p.

Weber, Max. *Économie et société*, traduction de l'allemand. Paris : Plon, 1971, 458 p.

Wittfogel, Karl Augustus. *Le Despotisme oriental. Étude comparative du pouvoir total*, trad. de l'anglais, Paris, Les Éditions de Minuit, 1977, 655 p.

Wong, Kuan-yiu et David K.Y. Chu, (éds.). *Modernization in China. The Case of the Shenzhen Special Economic Zone*, Oxford, New York et Hong-Kong, Oxford University Press, 1985, 229 p.

ACADEMY II

Academy of Humanities and Social Sciences

SYMPOSIUM:
CANADA AND THE GROWING
PRESENCE OF ASIA

ROD DOBELL and K. LORNE BROWNSEY*

Canada in the Pacific Community†

INTRODUCTION

In this paper, I would like simply to sketch some broad background relating to the Pacific region and the emergence of the concept of a Pacific community. As other papers in this volume describe in some detail various aspects of regional economic performance and trade relations, I will direct my remarks towards the developing structures for economic cooperation in the Pacific, and the role Canada can play in relation to them. In doing so I will emphasize four points:

i) There is emerging a world of three major trading blocs, but this need not be a bad thing. In a world of "open" regionalism, regional initiatives can promote the liberal multilateral trading and economic system on which middle powers like Canada must depend.

ii) Within this overall system, the Pacific region has emerged as a major economic force, and in that region there is emerging a distinct concept of economic cooperation which I argue is particularly appropriate to our times.

iii) For Canada, the Pacific region represents an increasingly important economic challenge, and there is a constructive role to be played by Canada in the emerging institutional structures of the region.

iv) The major challenge to be faced in economic cooperation in the Pacific — as well as in the rest of the world — is that of environmental degradation, and environmental — as well as economic — refugees. Management of the global commons is a task to be addressed urgently.

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THE NEW REGIONAL ORDER

Before turning to developments in the Pacific region, a few general observations about the changing structures of economic activity and world trade are in order.

It has become a cliché to note that we have seen the end of hegemony in the world trading system. We now live in a multi-polar world and, in these days, a particularly unstable and unsettled world at that. It is simply no longer the case that one can rely upon a single powerful policeman for the world economy. There are a number of key players, all of whom exercise significant political influence. And there are many players in a position to exercise some influence from time to time.

Secondly, we are also witnessing the decreasing relevance of national frontiers; trade across boundaries is being replaced by the emergence of a borderless economy. The phenomenon of globalization is resulting in changing economic structures internationally. The relative importance of trade in goods is counterbalanced by significant increases in trade in services, international investment flows, flows of people for business and immigration purposes, transfers of technology and transmission of knowledge. In short, greater economic interpenetration is the most striking feature of current economic relationships. Trade policy can no longer deal solely with tariffs and border measures and must extend to include regulatory harmonization and policy coordination between nations. At the same time, it should be recognized that regulatory and social policies relating to the globalization phenomenon may strike at the heart of domestic political structures and interest group agendas, posing difficult trade-offs between international obligations and domestic commitments.

Thirdly, in apparent lockstep with the forces of economic integration are those of democratization and political fragmentation. Along with economic integration come feelings of disempowerment and disillusionment, giving rise to appeals to ties of ethnicity, culture, and community for economic security. One sees nationalism emerging in many regions of the world, not just in Eastern Europe, although certainly most prominently there at the moment.

And finally, the process of atomization, if you like, the twilight of hierarchical structures, the emergence of a much more flexible set of relationships, coalitions amongst smaller enterprises whose shifting alliances can challenge multinational enterprises for influence in the world economy and create all kinds of ties across national boundaries.

These then are some of the forces shaping or propelling us towards new arrangments or initiatives to promote trade, many of which are regional in nature. In particular, as we all know, Europe is on the move, changing from the paralysis of "Eurosclerosis" to a new dynamism in quite stunning ways. This is good for all of us. European integration has, so far, created far more trade than it has diverted and should continue to do so as linkages are developed between the European Community and the EFTA states (the Nordic countries,

Switzerland, Austria) and ultimately central and eastern Europe. Within this large and powerful economic grouping, Germany will be the centre.

In North America, still the largest economic entity in the world, the United States is the undisputed dominant power. Integration is not occurring at the pace witnessed in Europe, although the Canada/U.S.A. Free Trade Agreement and discussions currently on-going with regard to a free trade agreement between Mexico and the U.S.A. (and Canada reportedly considering joining the talks) suggest that some version of a North America free trade zone may come to pass in the not so distant future. Relations with Latin America, however, both South and Central, remain surprisingly underdeveloped and a Western Hemisphere free trade zone stretching from the Arctic Circle to Tierra del Fuego, is on a more remote horizon yet.

About Asia, much more will be said below, but for purposes of completing this initial sketch of trading blocs and regional initiatives, let me simply note that a Japan-centred Asian grouping, very diverse but with rapidly growing internal trade links, has definitely emerged.

So we have a picture of a new, interdependent, interpenetrated economic world with three major regional groupings, centred respectively on Germany, the U.S.A., and Japan. And, as noted earlier, economic relations among them increasingly involve movements of people, service and investment flows, technology transfers and information exchange — all manner of interactions to which frontiers and borders are increasingly irrelevant.

One should not overlook the Orwellian possibilities in all this, or underestimate the potential for conflicts as economic interpenetration increasingly over-rides old ideas of domestic sovereignty. But neither should we assume inevitable confrontation amongst these blocs. So long as these regional groupings maintain an open posture, promoting intra-regional relationships without erecting external barriers, they can be consistent with — and, indeed, lead — the successful development of the liberal world trading environment which must be sought in the Uruguay Round and beyond.

Within each region, and between regions, governments can cooperate to establish a framework within which enterprises compete, and that is constructive, not to be feared.

Thus we can turn to a discussion of the Pacific region, without any preconception that the emergence of closer ties there poses a threat to our world order.

CANADA IN THE PACIFIC ECONOMY

We are told endlessly that the "Pacific Century" is upon us and that this region will be the driving force behind the future growth of the world economy. The remarkable economic and trade performances of Japan and the newly industrialized economies (NIEs) of East Asia buttress such claims. Numerous forecasts suggest that by the year 2000 the Asia-Pacific region will account for over 60 per cent of the world's population, 50 per cent of global production of goods and services and 40 per cent of consumption. Trans-Pacific trade is

expected to grow from a 1987 level of $275 billion to close to $1 trillion by the turn of the century.

Accompanying the enhanced competition among advanced high-income countries and growing global rivalry among multinational corporations is the emergence of Japan as the second largest national economy (and principal lender) in the world. In the 1950s Japan accounted for only about 2 per cent of GDP in the industrialized countries. By 1985, Japan's share was 16 per cent, and in the OECD Economic Outlook of December 1989, the forecast for 1990 was 20.5 per cent of the OECD total. The higher rate of economic growth in Japan, evident in Table 1, has altered dramatically Japan's relative position in the world economy.

High rates of economic growth among the group of newly industrialized economies (NIEs) have also altered relative competitive positions in international trade. Hong Kong and Singapore have enjoyed robust economic growth based on an outward-looking trade strategy. In conjunction with domestic policies that have shifted from an emphasis on import substitution towards a policy of export orientation, countries such as South Korea and Taiwan have become powerful competitors in the basic heavy manufacturing industries. As Table 1 indicates, each of these Asian NIEs has enjoyed higher rates of economic growth than Japan. The NIEs are a diverse group, with differences in their domestic policies, in their social and economic structures, and in their external trade and payments regimes, but several of them have emerged as significant international competitors in industries such as automotive production, steel, and shipbuilding, which were traditionally the preserve of the industrialized countries.

A third group of countries in the region can be characterized as those developing economies with large populations that are shifting from a heavy agricultural orientation toward more industrial production and trade. Economies such as Thailand, the Philippines, Malaysia, and even India and the People's Republic of China are following the path trod by Hong Kong and Taiwan, by pursuing more outward-looking policies and expanding their production and exports in labour-intensive, light manufacturing and consumer products. These so-called DAIES (developing agro-industrial economies) must be expected to exercise significantly increased influence in the coming decade.

Seiji Naya in a recent study for PECC[1] tells this story of Pacific economic growth and changing patterns of production and trade as one of endless evolution, with the United States, and now Japan, passing through periods of comparative advantage, from labour-intensive goods, to heavy manufacturing, to the current emphasis on technology-intensive goods; the NIEs are already handing off to the large ASEAN countries their role in exports of labour-intensive and light industrial products and are now moving into heavy industry and more sophisticated goods; the ASEAN countries (other than Singapore) are looking to become the next tier of NIEs; and through it all, Canada, Australia, and New Zealand are trying to move from their position as producers of natural-resource-based products toward exporters of more sophisticated

Table 1. Growth of Production in Pacific Economies

Real Gross Domestic Product
Average Annual Growth Rate (percent)

Countries	1965-80	1980-87	1988[2]	1989[2]	1990[2,6]	1991[6]
Developed Countries						
Australia[1]	4.2	3.2	3.7	4.9	0.8	3.2
Canada	5.0	2.9	5.0	2.9	1.9	1.4
Japan[1]	6.3	3.8	5.7	5.1	4.3	3.1
New Zealand[1]	2.5	2.9	0.6	1.4	2.9	1.8
United States[1]	2.7	3.1	4.4	3.0	2.5	2.8
Asian NIEs						
Hong Kong	8.6	5.8	7.4	2.5	3.0	5.5
Korea Rep.[1]	9.5	8.6	12.2	6.7	7.0	7.0
Taiwan[3]	8.5[5]	6.3[5]	7.8	7.2	6.9	7.3
ASIAN Countries						
Indonesia[1]	8.0	3.6	5.5	5.9	6.4	5.6
Malaysia[1]	7.4	4.5	8.7	8.5	8.1	7.5
Philippines[1]	5.9	-0.5	6.8	5.5	5.5	6.1
Singapore[1]	10.1	5.4	11.0	9.2	8.1	6.6
Thailand[1]	7.2	5.6	11.0	11.0	9.1	8.4
China, People's Rep.	6.4	10.4	4.2	3.9	5.4	5.9

[1] GDP and its components are at purchaser values.

[2] Real GDP/GNP.

[3] Source: White Paper on International Trade, Japan 1988, Japan External Trade Organization.

[4] 1964-1979.

[5] 1980-1985.

[6] Estimates from the 1990-91 Forecast of Real Economic Growth of Fourteen PECC Economies (Table 1 in the Pacific Economic Outlook 1990-91)

Sources: World Development Bank, Annual Report 1989; Pacific Economic Outlook, 1989-1990/1990-91; Pacific Economic Cooperation Conference.

manufactures and increasingly to re-orient their economies toward Asia-Pacific markets.

For Canadians — and for British Columbians in particular — the significance of these trends in the Pacific is readily apparent. At the national level, for close to a decade, our trans-Pacific trade has exceeded our trans-Atlantic trade — Canada's trade with Japan alone is equal to its combined trade with the four largest Western European economies. At a provincial level, the Asian countries of the region have become British Columbia's premier export market, with exports to the Pacific exceeding 40 per cent of its total exports, an amount equivalent to that sent to the United States. Table 2 illustrates the degree to which British Columbia is more integrated with the Pacific Rim economy than is Canada as a whole.

Table 2. Canada and British Columbia Trade — 1989 (Percentages)

	Imports		Exports	
	Canada	B.C.	Canada	B.C.
U.S.A.	65.2	43.1	73.4	40.8
Pacific region[1]	14.2	46.3	11.9	40.3
Western Europe[2]	13.4	6.8	9.9	16.0
Total	92.8	95.2	95.2	96.1

[1] Australia, Brunei, China, Hong Kong, Indonesia, Japan, Malaysia, New Zealand, Philippines, Singapore, South Korea, Taiwan, Thailand.

[2] EEC and EFTA.

Sources: Statistics Canada, Catalogues 65003, 65006

The Asia Pacific region is also an important source of immigration — over 40 per cent of immigrants to Canada now come from Asia — and foreign direct and portfolio investment.

With respect to investment, two fundamental developments, both of which have profound implications for the Canadian economy, have altered the competitive position of the U.S. economy. First, the advantages to U.S. producers from economies of scale in production and innovation have declined

at the same time that improvements in the technology and infrastructure of transportation and communications have increased global competition. Since Canadian manufacturing is dominated by U.S. multinational enterprises, the decline in the relative position internationally of U.S. firms has important implications for Canada. Many Canadians express concern about how U.S. subsidiaries will adjust to the Canada-U.S.A. Free Trade Agreement, but the real issue in fact is how these subsidiaries will respond to global competition.

Canadian firms are poorly positioned to take advantage of emerging opportunities in the Western Pacific. Canadian direct investment abroad is heavily concentrated in the United States and the United Kingdom, which account for 71 per cent and 8 per cent respectively. Only Indonesia and Australia among Western Pacific economies account for more than one per cent of Canadian foreign direct investment.

Similarly, investment by Pacific economies in Canada is very limited. Together the United States and the United Kingdom account for over 80 per cent of foreign direct investment in Canada, while Japan is the only Pacific economy represented among the ten largest foreign holdings in the Canadian economy. Although Japanese investment in Canada has grown very strongly in 1989 — up 93 per cent — the stock of Japanese direct investment in Canada is only about US $3.9 billion or about 1/3 the level of investment in Australia and 1/20 the investment in the United States. Overall, Canada has attracted less than 2 per cent of Japan's foreign direct investment, and in 1989 was still not among the top three destinations for this purpose.

Among other Pacific economies, investment from Hong Kong and New Zealand has grown strongly in recent years (foreign direct investment from Hong Kong has risen from $168 million in 1985 to $800 million in 1988 — not including funds accompanying migrants), but the absolute amount remains modest. As the Korean economy has matured it has also begun to invest abroad. The stock of Korean investment in Canada is presently concentrated in a few projects, such as the Hyundai plant in Bromont, Quebec. However, since Canada is attracting about 8 per cent of Korea's foreign investment, the stock of Korean investment could grow rapidly in the future.[2]

The second fundamental development related to foreign investment is that the comparative advantage of the north American economies is changing as their shares of specialized factor endowments, such as a highly qualified workforce or modern technologically-advanced physical capital, are declining relative to the positions of the other high-income countries. This is most evident in the comparison with Japan where strong economic growth and high savings rates have been translated into high rates of investment in physical and human capital as well as in research and development.

If Canada is not to experience further decline in its relative economic position when compared with the high income European countries, Japan, or the newly industrializing economies of the Pacific Rim, then Canada must achieve higher productivity growth in the domestic economy and strengthen trade and investment links with the dynamic Pacific economies. Canadian productivity growth has consistently ranked second last (ahead of the United

States) among the industrial countries and lags far behind the productivity growth performance of the NIEs. The economic rationale for pursuing the Canada-U.S.A. Free Trade Agreement is to stimulate productivity gains and enhance the competitiveness of the Canadian economy. Realizing these potential economic gains, however, will depend upon the ability of Canadian firms to seize opportunities in offshore markets, particularly in the Pacific. And that will depend particularly on people. The story here is also quite remarkable.

Following a long decline in immigration levels in Canada, beginning in the mid-1970s, the post-1986 levels have begun to climb. Preliminary data suggest that net immigration reached over 160,000 in 1988. The federal government has set its planning level for 1990 in the 165,000 — 175,000 range and is engaged in a broad consultative process to establish the levels for the medium-term future. Particularly relevant to Canada's and British Columbia's interests in the Pacific region are the significant changes occurring in the sources of its immigrants. The predominance of traditional countries of origin, including the United States and European countries, has been supplanted. In 1988, it is estimated that immigrants from Asia and the Pacific accounted for 43 per cent of total immigration (Table 3) and the Pacific Asian countries of Hong Kong, the Philippines and Vietnam occupied the first, fifth and seventh places of the top ten countries of last permanent residence of landed Canadian immigrants.

Table 3. Landed Immigrants By World Area of Last Permanent Residence: 1987-1988

Source	1988*		1987*	
	Number	%	Number	%
Asia and The Middle East	22,132	13.1	19,948	13.1
Asia and the Pacific	69,286	43.0	58,149	38.1
Americas (excluding the US)	22,274	13.8	29,009	18.9
United States	6,520	4.0	7,983	5.2
Europe	40,556	25.1	37,660	24.7
World Area not Stated	0	0.0	2	0.0
TOTAL	160,768	100.0	152,751	100.0

* Preliminary

Sources: 1987 data: Unpublished data from Canada, Employment and Immigration. 1988 data: *Immigration to Canada: A Statistical Overview* (CEIC, 1989).

The economic objectives of Canadian immigration policy have given birth to a business immigration program designed to encourage immigration that

will create jobs for Canadians. From 1984-1988, 13,124 business immigrants were landed in Canada.

Again, it is the Asia-Pacific region that is the primary source of business immigrants. In 1988, 53 per cent of all entrepreneurial immigration was from this region. Hong Kong, with 956 visas; South Korea, with 320; and Taiwan with 258 occupied three of the top five countries of last permanent residence for entrepreneur immigrants.

The importance of immigration to the Canadian economy needs to be underscored. Not only do immigrants bring with them skills and resources which enable them to contribute to the development of their new homeland, but they also often continue to operate within a network of business and personal contacts established prior to emigration, which, in turn, provides new conduits for linkages between countries.

As suggested by the above discussion, the Pacific Basin has been one of the principal engines in the process of growth and globalization of the world economy, and Canada is one of its principal beneficiaries. Canada shares with other countries in the Asia-Pacific region a fundamental interest in the maintenance of an open, multilateral trading environment, and particular initiatives need to be considered in the context of that fundamental and mutual interest.

While to a considerable degree the evolution of the Pacific will be dominated by the working out of the economic and political relationship between the United States and Japan, Canada as the third largest economy in the region has a key role to play and fundamental interests to protect and promote. Indeed, Canada's strategic interest in maintaining and enhancing its links in the Pacific is greater now than ever before in its history, for at least two reasons. First, in the coming decade Canada will no longer be able to depend on maintaining a surplus in its trade with the U.S.A., given the necessary efforts the U.S.A. will be obliged to make to address its own deficit, and the longer-term implications of that for exchange rates and capital flows. Canada will therefore need to look elsewhere to generate the surplus it vitally needs to service its international liabilities. Given the uncertainty of developments in Europe in the aftermath of 1992 (an uncertainty compounded by recent developments in Eastern Europe) which raises the prospect of an inwardly-focused Europe in the short term, and given the overall dynamism and growth of the economies of the Asia-Pacific region, it is principally to the Pacific that Canada will need to look to make up the losses in its trade balance that will occur in North America as the period of an over-valued U.S. dollar comes to an end. Second, in order to maintain some degree of leverage and manoeuvrability in its bilateral relationship with the U.S.A. in the aftermath of the Free Trade Agreement, Canada needs to diversify its markets and economic relationships, and again the Pacific region offers by far the most likely avenue for such diversification.

Not only does Canada have a fundamental strategic interest in enhancing its links and position in the Pacific, but also Canada faces the reality that, whatever we do, already established patterns of trade, investment, communication, transportation and immigration are making us, as never before, a Pacific

nation. The question is not whether we shall be part of the Pacific, but rather how well we shall be prepared for our rapidly developing role as a Pacific nation.

Strengthening Canada's trade with the countries of the Pacific will depend fundamentally on the development of long-term relationships with our partners in the region, and on a greater degree of mutual understanding and familiarity with our Pacific neighbours. Such relationships can only result from a sustained and consistent effort to build the social, intellectual, political, economic (both trade and investment), transportation and communications links on which success in the Pacific trading environment depends.

Those relationships are all the more important as our trade diversifies away from resources and commodities to include a far greater component of processed goods and especially services. Such "higher value added" trade requires greater familiarity with the different requirements and practices of particular markets and the development of a greater degree of mutual confidence and understanding between buyer and seller. To date Canada has not been as active in building these essential links as have other countries such as Australia and the United States, in part perhaps because we have not been as aware as others appear to be of the stakes involved or of the opportunities available in the Pacific. Some initiatives in recent years such as the creation of the Asia-Pacific Foundation, the Asia Pacific Initiative and more recently the federal government's Pacific 2000 program have begun to reverse this deficiency but, given the magnitude and urgency of the task, they represent only a beginning.

For Canada, that web of human, institutional and investment relationships, which provides the essential infrastructure on which trade and economic relations depend, has been well established over the last century with the economies of Europe and the United States, and that very success may have distracted us from paying sufficient attention to the new environment emerging in the Pacific and to its fundamental implications for our future prosperity. We are at a relatively early stage, therefore, in establishing such relationships with our Pacific partners. To remedy that relative weakness, and to equip ourselves to participate more effectively in the Asia-Pacific region, will require that Canada, and especially British Columbia, devote significantly more attention and resources to strengthening our presence and links in the Pacific than ever before; the situation demands an investment that will enable Canada and Canadians to deal as effectively in the Asia Pacific region as in Europe or the United States.

AN EMERGING PACIFIC COMMUNITY

Economic cooperation, or regionalism, in the Pacific is evolving, and should evolve, differently from earlier models in the rest of the world, or indeed from the earlier visions expressed for the Pacific.

Two main alternatives have been suggested with regard to institutional development in the Pacific. The first might be described as a comprehensive

institutional approach leading to full regional economic integration. The idea of a Pacific free trade agreement was first raised by Professor Kiyoshi Kojima in 1968 and has resurfaced in various forms in subsequent years. The Pacific is, of course, already home to three sub-regional trading agreements — the Canada-U.S.A. Free Trade Agreement, the Australia-New Zealand Closer Economic Relations Trade Agreement, and the Association of South East Asian Nations — and there has been considerable discussion around the notion of broadening these agreements to include other trading partners. However, the jump from sub-regional to regional integration faces substantial obstacles. Free trade agreements derive much of their strength from the similar heritages and levels of economic development of their member countries. But the Pacific region is notable for its economic and cultural diversity. Furthermore, the ASEAN countries are particularly reticent about such proposals, fearing that their interest might be overwhelmed by those of the larger, more developed countries.

A very different view of Pacific regionalism is one that places less emphasis on formal institution-building and more on information flows, consensus-building, or negotiating alliances for policy initiatives by a group of countries that wish to take a lead in solving international problems. Institutions might be established to this end, but their role would be more limited, performing particular functions according to the changing needs of the times. This form of regionalism has found its expression in the research and consultation activities of organizations such as the Pacific Trade and Development Conference (PAFTAD), the Pacific Business Economic Council (PBEC) and the Pacific Economic Cooperation Conference (PECC). PECC has been particularly effective in bringing together the tripartite participation of academics, businessmen and government officials to review through its working groups and policy fora "matters of common concern to Pacific Basin countries".[3] In recent years the most active of these groups have been the Trade Policy Forum, the Pacific Economic Outlook working group, and groups dealing with three natural-resource-based sectors: agriculture, minerals and energy, and fisheries. Recently, new PECC groups were formed to examine telecommunications, transportation and tourism as well as science and technology.

The major stumbling block of the PECC as a foundation for consensus-building in the Pacific arises from its past inability to develop effective communications with governments. Publication and dissemination of reports on PECC activities, and other uses of its Forum and Task Force outputs, have been limited and not very imaginative. Perhaps more important, the National Committees in some member states have demonstrated only limited success in building bridges with the relevant government officials, and especially with political leaders. However, with the proposal of Prime Minister Hawke of Australia for a Pacific forum of economic ministers, a vehicle for more effective PECC/government linkages, and, more importantly, greater Pacific cooperation and dialogue at an intergovernmental level, has emerged. After considerable diplomatic activity, the first Ministerial meeting of this initiative

was held 5-7 November 1989 in Canberra. It has acquired the name APEC — Asia Pacific Economic Cooperation — and at its first meeting twelve countries were represented. For political reasons, China, Taiwan and Hong Kong, which most PECC members wanted included, were not present. The meeting was sufficiently "up beat" so that all participating delegations agreed to at least two subsequent meetings, one in Singapore in 1990, and one in Seoul in 1991.

At least two important questions arise from the APEC initiative: 1) does this inter-governmental consultative group constitute a first step toward a Pacific version of the OECD? 2) How does its initial set of priorities and procedures relate to PECC?

On the first question, the jury will be out for some time. There is no evidence yet that there will be a formal secretariat created to serve APEC. Caution is everywhere. On the second question, the relation of this effort to PECC will be tested by the results of the next PECC Trade Policy Forum, held in order to develop consensus views on the issues that appear to be crucial to the success of the GATT negotiations. It is the intent of PECC to provide significant input to the mid-1990 APEC ministers meeting which will also seek consensus views with regard to the GATT. Close consultation between PECC Trade Forum members and their national government advisors to Trade Ministers is to be attempted in the preparations for a meeting of APEC trade ministers in Vancouver in September 1990. Thus the PECC is taking a risk — can it be relevant and effective in strengthening the input to an APEC ministerial meeting? In the context of the rather constrained conditions surrounding the "crunch period" in a trade negotiation it is indeed a question how "full and frank" intergovernmental communication will be.

Past and recent developments, particularly with regard to PECC and APEC, point to the distinctly different structures for cooperation in the Pacific from those elsewhere. This very loose kind of regionalism can be claimed to be an effective vehicle for both accommodating the diverse interests in the region and lessening trade tensions and conflict. Indeed, one can argue that this multi-partite, non-governmental, consultative forum is precisely the institutional form appropriate for the more pluralistic, participatory, consensus-building approach essential in contemporary modes of governance.

Canada has played an important role in the evolution of PECC institutions to date. As Chairman of the Canadian National Committee for Pacific Economic Cooperation in the period leading up to the 1986 PECC meeting in Vancouver, Eric Trigg was instrumental in the solution to the problem of participation by Taiwan (as Chinese Taipei) along with the People's Republic of China. The current Chairman, Bill Saywell, President of Simon Fraser University, has been a moving force in the creation of the international secretariat to PECC, now established in Singapore, and in further institutional developments to support economic cooperation in the Pacific. For a variety of reasons Canadian leadership is both trusted and potentially definitive.

Developments in the Asia-Pacific region would suggest the following tentative conclusions *vis-à-vis* economic cooperation in a Pacific Community:

1. we won't see a "Pacific community" in the sense of the "European community" — that is, a close-knit collection of countries pursuing political union;
2. we won't see a Pacific OECD as a sequel to a "Pacific Marshall Plan";
3. we won't see a Pacific Free Trade Area, "stepwise" or otherwise;
4. we will see a Japan-centred investment network;
5. we will see growing economic interpenetration through trade, corporate ownership, finance, migration, etc.; and
6. we will see a stronger PECC-APEC forum to resolve regional questions and pursue common interests in other fora. Some version of the APEC intergovernmental discussions, with support from PECC, will provide the flexible, information-based, consensus-building framework necessary for multipartite interaction in a region as diverse as the Pacific.

SUSTAINING THE ENVIRONMENT

Any lasting benefits from the economic dynamism of the Pacific region depend increasingly on mankind's ability to deal successfully with the vast array of environmental problems that have accompanied the unprecedented levels of economic activity much of the world has experienced in recent decades. Simply put, the very scale of human economic activity now poses a devastating threat to the natural environment and human security. We in developed countries must not lose sight of the fact that it is our relentless pursuit of material well-being, financed by an equally relentless drawdown of the earth's natural resource endowments, that is largely responsible for the mess we are in. Similarly, we must remember that much, if not most, of the world's population knows quite a different story from ours — hunger, illness, unemployment and illiteracy are but a few of its chapters. The aspirations of these people for a better life depends on unprecedented rates of economic development. The disturbing truth is, however, that based on our current practices in promoting economic growth, development of this magnitude will most assuredly be ruinous. This is clearly a dilemma that requires creative thinking and a fundamental commitment to national, regional and international cooperation. If we fail to achieve clear international agreement on an appropriate "global bargain" to deal with questions of global change, we most assuredly face a future scarred by tension and conflict founded in environmental degradation and resource scarcity.

Consider briefly one example of a most serious environmental problem and how we might address its resolution. The "greenhouse effect" is viewed by many as one of the most serious threats we face. Global warming is expected to cause shifting precipitation patterns and rising ocean levels, with catastrophic effects on food producing regions and low-lying countries. How can we avoid this crisis? Part of the answer is straightforward — to reduce global carbon dioxide emissions very substantially. Implementing such reductions is, unfortunately, not so simple and would require deep cuts in the world's

use of fossil fuels through increased energy efficiency and the development of new non-fossil energy sources.

These changes must be made globally and will carry with them high costs, which will hit hardest in the developing countries which lack the accumulated wealth, technical capacity and infrastructure that more easily enable the rich countries to reduce their energy use. Consequently, solving the greenhouse problem requires international cooperation on two fronts — defining and enforcing an international program of emissions reductions and equitably sharing the resulting costs. A number of proposals have been put forward to promote this type of cooperation, most of which involve raising revenues by measures that discourage fossil fuel use and making expenditures to ease the adjustment burden in developing countries by supporting research and development, technology transfers, and investment directed to sustainable low emissions development. There can be no disputing that such a scheme is fraught with difficulties and implementation problems. But the likeliest objection to the plan — that such large resource transfers from the industrial to the developing world are politically impossible — is simply not tenable. Current energy use trends are not sustainable. The costs of changing course are rightly borne in large measure by those who have benefitted most from fossil fuel exploitation. It is also the case that there should be no free riders in such a scheme.

Global bargains of this sort are imperative if there is to be any hope of reconciling the legitimate aspirations for substantial economic growth in the developing world with the need to sustain and enhance the earth's ecological foundations. The Pacific region, with Canada as one significant influence, has the capacity to provide leadership in the area of sustainable economic development. Individual nations in the region have world-leading technologies and expertise related to pollution control, energy conservation and sustainable development. Enthusiasm must be sustained for continued research and development in these fields and for sharing knowledge with developing countries. The combined foreign aid budgets of the countries in the Pacifc region (which include the two largest donors in the world) and Japan's immense surplus offer a potentially effective means of facilitating the development of sound environmental policies in the developing countries of the region through debt reduction schemes, technology transfer and other aid/economy/environment linkages.

CONCLUSION

We cannot take for granted that the path through the 21st century — the century of the Pacific — will be smooth. The problems are many, the solutions are complex and expensive. Furthermore, a warning sounded a few years ago for ASEAN countries remains equally relevant for Canada today.

> It is beyond dispute that the contemporary international environment is becoming more hostile: this poses major economic challenges and forces major structural adjustments. While it is fashionable to speak of

> the 21st century as the century of the Pacific, the possibility that these adjustments will take place in as accommodating a world economy as in the past is remote.[4]

But, it seems clear that a concept of a Pacific community is emerging and Canada has an important role to play in that community. Playing that role well will be important to us all.

ENDNOTES

1. Seiji Naya *et al.*, "Pacific Economic Cooperation in the Global Context", draft report prepared for the 7th PECC meeting, Auckland, New Zealand, November 1989.
2. It should also be noted here in passing that there are immense data problems with regard to tracking foreign investment in the region. Given the importance of this topic, support for intensified academic work, and for Statistics Canada efforts to pursue bi-national and international exercises in reconciliation of balance of payments statistics and data on capital flows and direct investment — such as those now contemplated with Japan and Korea — is crucial to informed business and policy decisions.
3. Australia, Brunei Darussalam, Canada, China, Chinese Taipei, Indonesia, Japan, Malaysia, New Zealand, the Philippines, Singapore, South Korea, Thailand and the United States now hold full membership in PECC, alongside representatives from the Pacific Island Nations, PBEC and PAFTAD. The U.S.S.R., Hong Kong, Mexico, Peru and Chile have worked with various PECC task forces and fora over the years and all but the U.S.S.R. have made formal application for full membership.
4. Remarks made with respect to ASEAN, July 1987 — Report of the Group of Fourteen.

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The Evolution of Income and Competitiveness in the North Pacific Rim†

I. INTRODUCTION

Things tend to be more expensive in the richer countries, and growth is faster in Asia than in North America. In this paper, we dig deeper into these everyday beliefs, and assess the extent to which they are linked together. As we do so, we shall be showing that things being more expensive in Canada is simply a part of the process whereby trading opportunities are created in the Pacific Rim. That growth should be faster in Asia than in Canada will also be shown to be a natural consequence of starting with lower levels of income and productivity.

Putting these two strands together, we shall argue that as this process unfolds over the next twenty years, we should expect to find the exchange rates of the Asian countries rising in real terms, relative to the Canadian and American exchange rates, and their growth rates slowing down towards figures more typical of the richer countries. Both of these results are seen to be the signs of successful operation of the convergence process, with the balance of cost competitiveness then favouring the poorer countries in which economic growth has so far been stalled for one of a variety of reasons.

The signs of this sequential development are easy to find, and include continual changes in the pattern of production and trade around the Pacific Rim. For example, in footloose sectors such as consumer electronics, production has often moved from North America or Japan to Hong Kong, South Korea, Singapore and Taiwan. Subsequently, or in different sectors, production has devolved from these regions to Malaysia, Thailand and China's Special Economic Zones. There seems to be something of a pattern, whereby production in some key industries appears to move to successively poorer countries.

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Gaining insights into the sources of this evolution not only might serve to explain an interesting period of Pacific Rim history, but might also help to illuminate the possible future evolution of production and trade patterns in this region. For Canadian governments and firms, such knowledge can assist in the formulation of trade policy and investment strategies.

As the standard 'workhorse' models of international trade are founded on current and unchanging labour productivities or factor abundances, they can provide little insight into such developments. We shall therefore take an alternative approach, building on and integrating two strands of research already employed in the context of economic convergence or 'catch-up', and the links between real income and real exchange rates. We describe these mechanisms, test them on Pacific Rim data, and draw their implications for regional trading patterns.

This will be done in several stages. Section II describes the nature of the linkages among income levels, growth rates, price levels and competitiveness. Section III more precisely defines 'purchasing power parities', price levels and real exchange rates. Section IV presents tests of economic convergence in the North Pacific Rim, while Section V describes the statistical link between real income and price levels. Finally, Section VI discusses the implication of the results for the evolution of production and trade patterns in this region, and possible impact on the Canadian economy.

II. SOURCES OF EVOLVING COMPARATIVE ADVANTAGE

Since it is increasingly easy to divide the production of goods and services among a variety of source countries, whatever may be the label on the final product, the location of production activity tends increasingly to be determined by relative costs. A dynamic theory of production and trade should explain why costs grow at different rates across countries. To explain Pacific Rim developments, it should also describe why this evolution might depend on the levels of real income.

We propose to develop and test a view which combines the notion of economic convergence with the well-documented link between real income and real exchange rates. We subsequently describe the relationship between real exchange rates and 'competitiveness' in particular industries.

Economic Convergence

Most simply stated, economic convergence means that, within a given set of countries with other things held constant, those with initially lower levels of per capita income or productivity will exhibit higher growth rates of these variables. There are two critical elements needed to support such a view. First, there must be reasons to think that some key factors influencing productivity can be passed from one nation to another, and that the techniques and knowledge already employed in the richer countries are potentially applicable in the poorer countries. Second, there must be some notion of the necessary conditions that need to be present in a poorer country for it to 'take off' into

sustained growth along a path that might converge with those of the richer countries.[1]

For the research reported in this paper, we shall not explore why the countries in our sample had such different levels of GDP per capita at the beginning of the 1960s, but shall test whether they can all be represented as now on the same convergence path towards North American levels of income and productivity. If we find some evidence of this type, as we shall, that will leave open the question of why their income levels were so different at the beginning of the period. One possible justification for us treating all these nations as equally open to convergence now, and leaving aside the explanation of how the initial differences came to pass, is that the massive opening up of world trade and investment since the mid 1950s, supported by substantial improvements in transportation and communications, facilitated international transmission of techniques, education and blueprints at an unprecedented rate.

In this preliminary analysis, we shall not be able to investigate the relative importance of the various channels whereby convergence and technology transfer might take place; we are rather looking to see if the broad aggregate data suggest that the process is taking place at all in the North Pacific Rim.

Real Income and the Real Price Level

The purchasing power parity (PPP) theory is a simple and popular view of the link between price levels and exchange rates. Its 'absolute' form states that the price levels in two countries will be identical when expressed in a common currency. Put differently, the ratio of foreign to home price levels will equal the domestic currency price of foreign exchange.

In empirical tests, this view has fared poorly both in the short- and long-run. The former is evidenced by the many studies which find apparent deviations persisting for several years.[2] Sustained departures from purchasing power parity may be due to one of several long-run determinants of real exchange rates. One which has received some study, and which we focus on here, is relative per capita real income or productivity.

In a well-known exposition, Balassa (1964) attributes this to greater productivity growth in tradable than in non-tradable goods. In the standard textbook models of international trade, poorer countries with lower cumulative productivity growth will possess a comparative advantage in production of services and other so-called 'non-tradables'.[3] If tradable goods prices are equalized through commodity arbitrage, poorer countries will exhibit lower levels of non-tradables prices and of price indices which include them. Balassa also presents simple cross-country evidence which backs up this view.[4]

As we shall reiterate later, if poorer countries have lower costs of labour and other services, even when adjusted for exchange rate differentials, then this will imply greater cost competitiveness, as long as there are sufficiently high levels of skill, and adequate economic and political stability, to provide attractive locations for the production of goods and services suitable for international trade.

When the assumed conditions are met, our complete story can be recapitulated as follows. Economic convergence implies that, other factors held constant, poorer countries tend to grow more rapidly. Given the links between real income and the exchange rate, these countries gradually lose their competitive edge over the richer countries, exposing a bigger cost advantage for any poorer countries that may not be growing as fast. At the outset of the convergence process, the richest countries in a group, e.g. the United States and Canada in the North Pacific Rim, will find themselves with very high cost levels relative to the poorer countries. However, as the process proceeds, the gaps in income levels and relative price levels will both tend to be eliminated. Finally, among countries with approximately equal levels of real income, trade will then depend more on differing tastes, talents, and resources, in the ways long studied by classical trade theory.

III. PURCHASING POWER PARITIES AND EXCHANGE RATES

We have so far not really explained what we mean by the real exchange rate, although it will be clear from the context that we mean the market exchange rate adjusted for different rates of inflation in the two countries being compared. To get further in our application of the notions of convergence and real exchange rates, we need to measure comparable price levels in each country. Only with such figures can we develop appropriate measures of real income levels in each country, which we need if we are to test the evidence for economic convergence.

For example, suppose we just looked at Japanese GDP in current Yen and used market exchange rates to convert it to Canadian dollars to compare with the Canadian figures for per capita GDP. These results would show a sharp rise in Canadian relative GDP in the first half of the 1980s, as the Canadian and U.S. dollars rose relative to the Japanese Yen, and then a sharp drop thereafter as the Yen increased in value relative to the dollars. For our studies of real growth, we need instead to compare the levels of real output in different countries, and for this we need comparably measured price levels.

Research sponsored by the United Nations [Kravis, Heston and Summers (1982), Summers and Heston (1988)] and by the OECD [Hill (1984), Blades and Roberts (1987)] has generated comparable price level and real output data for many countries [130 in Summers and Heston (1988)]. Dividing, for example, the Canadian price level (in CDN$) by the Japanese price level in Y[illegible] the same basket of goods and services, gives what is called the [illegible]asing power parity value of the Japanese Yen in terms of Canadian dollars. Constant-price estimates of real income in different countries are then converted into common units by use of the purchasing power parities. Dividing the current exchange market value of the Yen by the purchasing power parity value gives what we and others describe as the real exchange rate linking the two currencies. We also refer to it below as the relative or real price level, because a high value is indicative of a country with relatively high prices. This variable is also often used as a measure of international competitiveness, since

higher prices for the same basket of goods and services makes them harder to sell in world markets.

IV. TESTING FOR CONVERGENCE IN THE NORTH PACIFIC RIM

As we noted above, possible sources of economic convergence are several and often intangible. These include technology transfer, both via embodiment in new investment and through more general dissemination, and gradual achievement of factor price equalization. This makes it difficult to specify a simple analytical model of the convergence process.

As observed income growth results not only from higher productivity, but also from changes in capital and labour inputs, an ideal test for convergence would control for levels of inputs. Since this requires both a model of production and good input data, and since the latter are not available for many countries in our sample, we adopt a more modest approach. By expressing all levels in per capita terms, we can control for the effect of labour inputs to the extent that these are correlated with population. Also, as growth in the capital stock may be positively related to gross investment, we can control for the capital input by including investment as a fraction of GDP as an explanatory variable.

Finally, as linkages with the rest of the world are prime channels for technology transfer, the openness of an economy is a potentially important influence on the degree of observed convergence. Therefore, our most general model will take the form:

$$(y_t - y_{t-1})^{100} = \alpha + \beta y_{t-1} + \gamma i_t + \delta z_t \qquad (1)$$

where y_t is the logarithm of the ratio of domestic to U.S. real PPP-adjusted per capita income at time t, i_t is domestic minus U.S. investment as a fraction of GDP at time t, and z_t 'openness' at time t, measured as the average of exports and imports as a fraction of GDP. The dependent variable has the interpretation of a percentage change in 'y'. Convergence implies that $\beta < 0$, the direct effect of investment on capital accumulation implies $\gamma > 0$, and the hypothesized effect of openness implies $\delta > 0$.

In choosing our data sample, we start from the belief that, rather than being a unitary worldwide process, convergence is more likely to occur in well-defined groups of countries. Two possible characteristics of such a 'convergence club' are:

1) Sufficiently strong trade and investment links to permit significant flows of technology and information. Being a geographically coherent area with established trade links, the North Pacific Rim satisfies this criterion.
2) A similar enough initial level of development to permit assimilation and use of acquired information and technology. For instance, while Singapore can potentially utilize Japanese know-how, this is less likely for India.

As Delong (1988) has shown, choosing this 'club' on the basis of actual experience during the period under study (i.e. looking at the countries that are now rich rather than the ones that many years ago seemed to have equal chances of becoming rich) can bias the results towards accepting convergence. One must instead define a comparable sample based on information available at the beginning of the historical period under study.

In choosing our sample, we began with 1955 data from Summers and Heston (1988), which are available for Japan, Korea, Malaysia, the Philippines, Taiwan and Thailand. As Taiwan, an obvious member of any Pacific Rim 'convergence club', had the lowest per capita real income, all of these countries were included. As the earliest data for Hong Kong and Singapore show their incomes to be far above some members of this group, they are also included.

Given a very different economic system and dearth of data, there are strong reasons to exclude China. Thus, the main ambiguity concerns the inclusion of Indonesia. While its 1962 per capita income falls well below that of other chosen countries, its 1985 income is less than 10 per cent below that of the Philippines, which is a clear member of the *ex ante* 'club'. For this reason and for completeness, we have included Indonesia.

Therefore, our broadest sample includes Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, Thailand, Japan and Canada, all relative to the United States. To test the sensitivity of results to this choice, we will use three different samples:

1) The full sample listed above,
2) The Asian economies alone, and
3) The non-Japanese Asian economies.

Tests with the second sample will indicate whether Canada, which may be less integrated with the Asian countries and more integrated with the United States, is affecting the results. The third will show the extent to which Japan is acting as a special case.

We will also consider three different time-series:

1) A simple average of annual data for 1962-85, i.e. a pure cross-section.
2) 'Triennial' non-overlapping averages for 1962-85 i.e. eight separate observations for each country.
3) Annual data for the 1963-85 period, producing time series with 23 observations.

The longer time periods reduce the size of the sample of evidence, but also damp the cyclical fluctations which our model does not seek to explain. Furthermore, pooled samples allow for different relationships within and across countries.[5]

Tables 1 to 3 present the results for the full sample, Asia, and non-Japanese Asia, respectively. In Table 1, simple regressions of relative growth rates on the lagged per capita income variable indicate no significant co-efficients and adjusted R-squared values show an absence of explanatory power over all time-series. This clearly produces no evidence in favour of convergence.

Table 1. Testing Economic Convergence for Asia and Canada

	yt-1	it	zt	R2	SEE	RHO
CROSS SECTION						
	-0.077			-0.12	1.96	
	(0.09)					
	-1.068	0.200		0.45	1.55	
	(1.34)	(2.41)				
	-0.986	0.144	0.025	0.68	1.29	
	(1.49)	(1.94)	(2.05)			
TRIENNIAL						
	-0.025			0.00	0.86	0.35
	(0.05)					
	-1.423	0.300		0.44	0.77	0.38
	(4.72)	(6.97)				
	-1.357	0.244	0.027	0.46	0.67	0.27
	(5.05)	(5.89)	(2.38)			
ANNUAL						
	-0.504			0.01	0.95	0.36
	(1.34)					
	-1.652	0.319		0.21	0.94	0.31
	(5.36)	(7.51)				
	-1.589	0.286	0.025	0.23	0.91	0.28
	(5.16)	(6.88)	(2.17)			

Note: The dependent variable is the percentage growth rate of per capita GDP relative to the U.S.A., measured as a logarithmic first difference times 100. Variable y_{t-1} is the lagged logarithm of per capita real GDP relative to the U.S.A., i_t is investment as a percentage of GDP relative to the U.S.A., and z_t is the average of exports and imports as a fraction of GDP. R^2 is adjusted R-squared for the cross-section and Buse R-squared for the pooled samples. SEE is the standard error of the estimate, RHO is the estimated co-efficient of autocorrelation, and the t-ratios are presented in brackets.

Table 2. Testing Economic Convergence for Asia

	yt-1	it	zt	R2	SEE	RHO
CROSS SECTION						
	1.401			0.06	1.74	
	(1.24)					
	-0.253	0.158		0.39	1.63	
	(0.16)	(1.41)				
	-0.742	0.133	0.025	0.62	1.40	
	(0.53)	(1.37)	(1.75)			
TRIENNIAL						
	1.134			0.08	0.86	0.23
	(2.28)					
	-1.200	0.286		0.38	0.77	0.34
	(1.74)	(5.66)				
	-1.700	0.252	0.030	0.39	0.67	0.26
	(2.52)	(5.21)	(2.43)			
ANNUAL						
	0.775			0.01	0.96	0.31
	(1.41)					
	-2.979	0.394		0.20	0.93	0.30
	(3.93)	(6.84)				
	-3.538	0.392	0.036	0.22	0.91	0.28
	(4.70)	(7.04)	(2.90)			

Note: See Table 1 for description of reported variables.

However, when we account for varying investment rates, measured relative to U.S. levels, a different picture emerges. The explanatory power of the regression is increased and γ, the co-efficient on investment as a fraction of GDP, is positive and very significant. Point estimates suggest that a one percentage point increase in this variable is associated with a one-fifth to one-third percentage point increment to the per capita growth rate. More important, the negative and usually significant co-efficient of lagged real income now supports the convergence hypothesis. In the triennial and annual samples, point estimates relate a one per cent increase in relative per capita income to a 0.015 percentage point reduction in relative growth rates.

Finally, including 'openness' produces a slight improvement in overall fit and preserves the earlier signs on co-efficients. This has a positive and significant effect, with point estimates for δ relating a one percentage point increase in openness to a one-fortieth of one per cent increase in the annual growth rate. However, we wish to interpret this variable with some caution. Given that our dependent variable is measured relative to the U.S.A. alone, the precise interpretation of a multilateral explanatory variable is not entirely clear.

Table 3. Testing Economic Convergence for Asia Outside Japan

	y_{t-1}	i_t	z_t	R^2	SEE	RHO
CROSS SECTION						
	2.035			0.11	1.81	
	(1.48)					
	0.312	0.225		0.43	1.45	
	(0.21)	(2.09)				
	-0.466	0.158	0.019	0.34	1.56	
	(0.21)	(0.91)	(0.52)			
TRIENNEAL						
	1.514			0.14	0.86	0.18
	(2.91)					
	0.243	0.277		0.43	0.77	0.25
	(0.39)	(5.60)				
	0.384	0.281	-0.003	0.43	0.67	0.25
	(0.39)	(4.99)	(0.17)			
ANNUAL						
	1.315			0.02	0.96	0.29
	(1.90)					
	-1.382	0.386		0.22	0.94	0.25
	(1.83)	(6.66)				
	-1.983	0.373	0.016	0.22	0.92	0.25
	(1.94)	(6.17)	(0.85)			

Note: See Table 1 for description of reported variables.

The results of Tables 2 and 3 for smaller samples excluding first Canada and then also Japan are broadly similar. As cross-section regressions begin to suffer from the smallness of the sample size, we can attach little weight to these results. The common thrust of the remaining results is a continued positive and significant effect of investment on relative growth rates, with point estimates very close to those reported above.

The effect of 'openness' is preserved when Canada is excluded, but becomes insignificant with the exclusion of Japan. This sensitivity to the sample of countries suggests that convergence might not be as simple a process as we have so far taken it to be.

Finally, the reduction of the sample size successively weakens the evidence for convergence. In the full Asian sample, lagged relative real income continues to have a significant negative effect, but at a reduced level of significance. With the further exclusion of Japan, a marginally significant effect is found only if the annual data are used.

Given the apparent importance of investment, we conduct one simple experiment to study the nature of its role in convergence. Investment can affect ouptput directly through changing factor inputs, and indirectly if new technology is 'embodied' in new machinery, or if investment spending reflects an important means for importing ideas already sucessfully employed in other countries. In the latter cases, technological progress and capital accumulation become very closely linked.

To isolate the indirect effects, we must subtract the contribution of capital accumulation from observed income growth. As capital data are unavailable, we do this by constructing a hypothetical capital stock series through combining observed investment rates with assumed initial capital-output ratios and depreciation rates. From the sample of industrial countries in Helliwell and Chung (1990a), we choose the lowest depreciation rate (1.62%) and initial capital-output ratio (1.88). Together, these cause a given investment level to have the greatest impact on the capital-output ratio. This biases our experiment towards finding a direct effect of investment and against finding an indirect effect conducive to convergence. We then subtract the contribution of capital to per capita output growth, generating a series for productivity. We use the percentage growth of productivity implied by this series as our dependent variable.[8]

The results are shown in Table 4 for three different samples, but only for annual data. These indicate that even after controlling for different capital inputs, investment continues to have a positive and significant effect. Bearing in mind the limitations of our capital stock figures, our results are consistent with the embodiment hypothesis, with investment being an important channel for the international transfer of technical progress, or both. On the other hand, the lower point estimates of the investment co-efficient than in similar regressions above also indicate that the pure capital accumulation channel accounts for about one-third of the total effect.

In summary, our results imply that when differences in investment rates and openness are accounted for, there is broad support for the convergence

hypothesis in the North Pacific Rim as we have defined it. This result is only modestly sensitive to our choice of the 'convergence club'. Also, and as we might expect, the size of the remaining unexplained differences in growth rates suggests that many other factors influence growth patterns, particularly in the short-run. Finally, we have identified a tentative effect for openness, and perhaps most strikingly, a robust effect of higher investment rates on income and productivity growth.

Table 4. Testing Productivity Growth Convergence

	y_{t-1}	i_t	z_t	R^2	SEE	RHO
ASIA AND CANADA						
	-0.714			0.02	0.95	0.30
	(2.28)					
	-1.502	0.227		0.15	0.94	0.28
	(5.06)	(5.65)				
	-1.448	0.199	0.021	0.17	0.91	0.24
	(4.97)	(5.12)	(1.97)			
ASIA						
	0.136			0.00	0.96	0.26
	(0.29)					
	-2.687	0.296		0.13	0.93	0.27
	(3.85)	(5.43)				
	-3.057	0.290	0.031	0.16	0.91	0.24
	(4.44)	(5.55)	(2.63)			
ASIA OUTSIDE JAPAN						
	0.535			0.00	0.96	0.24
	(0.89)					
	-1.470	0.288		0.14	0.94	0.24
	(2.09)	(5.13)				
	-2.255	0.268	0.022	0.14	0.91	0.23
	(2.35)	(4.59)	(1.18)			

Note: See Table 1 for description of reported variables.

V. PRICE LEVELS AND INCOME LEVELS

As existing theories of the link between real income and prices are non-technical, they are agnostic regarding the functional form of the relationship. This may not be as critical in a sample of industrial countries as in our sample with more diverse income levels. As a way of checking the sensitivity to this functional form, we estimated both the linear model

$$P = \varepsilon' + \theta' Y \qquad (2)$$

and the log-linear model

$$\ln P = \varepsilon + \theta \ln Y \qquad (3)$$

where P is the 'real price level' or the ratio of the 'purchasing power parity' to the market exchange rate, Y is the PPP-adjusted per capita real GDP relative to that of the U.S.A., and 'ln' represents a natural logarithm.

As the signs of co-efficients and levels of significance are nearly always identical, we report only the log-linear results. Since θ represents an elasticity, these results are easier to interpret. Also, this form permits the important hypothesis, that convergence to U.S. income levels will lead to convergence to U.S. price levels, to be tested by a simple t-test on the estimated intercept. Since both real income and the price level are measured relative to the U.S.A., these variables have a natural logarithm of zero when U.S. levels are attained, implying a zero intercept.

As in our tests of convergence, we check the robustness or results by estimating over the full sample, Asia, and Asia ouside Japan, and over the three different time-series. We employ the same estimation techniques as for the corresponding samples above.

The results are presented in Tables 5 to 7 for Asia plus Canada, Asia and non-Japanese Asia, respectively. Beginning with the full sample (Table 5), the simple cross-section regression (1) confirms a strong positive relationship between relative real incomes and prices. The point estimate associates a 10 per cent rise in relative real per capita income with a 4 per cent appreciation of the real exchange rate. As the intercept is not significantly different from zero at the 95 per cent confidence level, the hypothesis that countries which attain U.S. real income levels will also have U.S. price levels cannot be rejected.

Regressions (2) to (4) are based on triennial averages. In (2), lnP is regressed on country dummies alone. Since lnP=0 for the U.S.A. by definition, the co-efficients estimate the fractional deviation of historical price levels from those of the U.S.A. Reported t-ratios test the hypothesis of equality with the U.S. price level. The results imply sub-U.S. price levels for all countries, and significantly so for all countries except Canada and Japan.

As the ranking of the intercept values in (2) (Canada, Japan, Singapore, Taiwan, Hong Kong, Malaysia, Korea, the Philippines, Thailand and Indonesia) closely follows that of per capita income, it is not surprising that

regression (3) reconfirms a strong link between price and income levels, with nearly identical point estimates to (1).

Table 5. The Price-Income Link in Asia and Canada

	(1)	(2)	(3)	(4)	(5)	(6)
lnY	0.400		0.408	0.362	0.393	0.304
	(8.99)		(16.0)	(7.06)	(13.7)	(5.61)
INT	-0.021		-0.029		-0.051	
	(0.29)		(0.96)		(1.43)	
ICA		-0.055		-0.021		-0.031
		(1.63)		(1.24)		(1.38)
IJA		-0.203		0.019		-0.013
		(1.65)		(0.25)		(0.17)
IHO		-0.555		-0.244		0.303
		(5.57)		(2.93)		(4.12)
IIN		-1.064		-0.093		-0.256
		(6.53)		(0.56)		(1.42)
IKO		-0.767		-0.080		-0.171
		(5.96)		(0.70)		(1.37)
IMA		-0.693		-0.119		-0.217
		(17.8)		(1.33)		(2.23)
IPH		-0.885		-0.115		-0.248
		(9.98)		(0.96)		(1.66)
ISI		-0.365		-0.004		-0.066
		(4.52)		(0.06)		(0.86)
ITA		-0.549		-0.064		-0.034
		(5.35)		(0.66)		(0.33)
ITH		-1.025		-0.256		-0.395
		(17.1)		(2.25)		(3.23)
R^2	0.90	0.82	0.77	0.94	0.45	0.74
SEE	0.11	1.07	0.87	1.07	0.96	0.74
RHO		0.64	0.74	0.41	0.88	0.78

Note: The dependent variable is the logarithm of the ratio of the price level to that of the U.S.A. lnY is the logarithm of the ratio of real per capita GDP to that of the U.S.A. INT is the common intercept. When country-specific intercepts are permitted, these are for Canada, Japan, Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand. R^2 is adjusted R-squared for the cross-section and Buse R-squared for the pooled samples. SEE is the standard error of the estimate, RHO is the estimated co-efficient of autocorrelation, and t-ratios are presented in brackets.

Regression (4) allows country-specific intercepts in (3). As we assume a common quantitative effect of real income changes on price changes, this allows us to separate the general impact of real income changes from the effect of country-specific factors, measurement error, or functional form. We find that the impact of income is still positive and significant, but with a slightly reduced magnitude. Furthermore, the individual intercepts do not allow us to reject the hypothesis that convergence to U.S. income levels leads to convergence in price levels, except for Hong Kong and Thailand, for which the 'converged' price level would remain below that of the U.S.A. The ranking of intercept levels is still correlated with the country income ranking, possibly suggesting different equilibrium real exchange rates. The standard error of the estimate indicates that, as might be expected, many of the cyclical fluctuations in real exchange rates result from other factors.

Table 6. The Price-Income Link in Asia

	(1)	(2)	(3)	(4)	(5)	(6)
lnY	0.397		0.376	0.341	0.343	0.285
	(6.69)		(7.71)	(6.48)	(7.25)	(5.13)
INT	-0.026		-0.086		-0.141	
	(0.26)		(1.03)		(1.79)	
IJA		-0.203		0.007		-0.023
		(1.65)		(0.09)		(0.32)
IHO		-0.555		-0.261		-0.318
		(5.55)		(3.12)		(4.28)
IIN		-1.064		-0.147		-0.306
		(6.51)		(0.86)		(1.67)
IKO		-0.767		-0.119		-0.206
		(5.94)		(1.02)		(1.62)
IMA		-0.693		-0.151		-0.247
		(17.7)		(1.65)		(2.49)
IPH		-0.885		-0.158		-0.288
		(9.94)		(1.29)		(1.90)
ISI		-0.365		-0.016		-0.085
		(4.51)		(0.24)		(1.08)
ITA		-0.549		-0.030		-0.065
		(5.34)		(0.30)		(0.62)
ITH		-1.025		-0.299		-0.435
		(17.0)		(2.57)		(3.48)
R^2	0.85	0.55	0.46	0.82	0.20	0.50
SEE	0.11	1.07	0.88	1.07	0.96	0.76
RHO		0.64	0.74	0.41	0.89	0.78

Note: See Table 5 for a description of reported variables.

Finally, regressions (5) and (6) are based on annual data. We do not report the regression on country dummies alone as results are effectively identical to those for (2). Regression (5) with a common intercept corroborates the point-estimates for cross-section and triennial data. Regression (6), with country-specific intercepts, again has a significant positive effect of income on prices, but with an even lower point estimate than for triennial data. This further suggests that the time-series and cross-section movements of prices are different. The specific intercepts imply that we cannot reject the hypothesis that U.S. price levels are attained upon convergence to U.S. income levels, except for Hong Kong, Malaysia and Thailand.

Table 6 shows the effects on these regressions of removing Canada from the sample. The qualitative conclusions are nearly identical to those for the full sample. Throughout, income has a significant positive effect on prices, albeit with a slightly lower quantitative impact than previously. Convergence to U.S. price levels cannot be rejected for the sample as a whole. When country-specific intercepts are allowed, this can be rejected for Hong Kong, Thailand and Malaysia, the latter for annual data only.

For Asia outside Japan (Table 7), income still has a positive and significant effect, but again at a lower rate than before. With a single intercept, the hypothesis of price level convergence cannot be rejected for the cross-section and triennial data, but can now be rejected for annual data, which imply convergence to a sub-U.S. price level. The country-specific results cannot reject price convergence, except for Hong Kong, Malaysia, Thailand and the Philippines, the latter for annual data only.

Thus our results support fairly strongly the view that long-run aggregate competitiveness, to the extent that it is appropriately measured by the price levels for a comparable aggregate basket of goods and services, is determined by relative income levels, with countries gradually losing their price competitiveness as their income levels rise.

VI. IMPLICATION OF OUR FINDINGS

Putting together the results in the previous two sections, they generally support the framework set out in the introduction. Our data cannot reject the possibility that the Asian countries under study are all on a growth convergence path that will eventually raise their levels of GDP per capita to equal those in the United States, or higher if their investment rates remain higher than those in the United States.[7] The results also suggest that for many years to come the per capita growth rates will remain higher in the Asian countries than in Canada, since the convergence process still has a long way to go.

Our results also confirm that continuing convergence in the levels of productivity and per capita income will be accompanied by rising relative price levels in the Asian countries, when compared to price levels in North America. This will tend to induce the footloose labour-intensive industries, which have migrated from North America through Japan to Korea, and from there to lower-income countries like Malaysia, to continue to migrate in search of

lower costs as the Asian countries grow in relative richness. In addition, of course, it will also become easier for North American firms to be competitive with Asian labour costs as these rise towards North American levels.

Finally, we should emphasize that our experiments with aggregate data provide only a preliminary and partial exploration of the complex and evolving patterns of income and competitiveness in the North Pacific Rim. While the broad patterns of convergence in the levels of real output and price levels may have been roughly established, the channels, timing, and longer-term outlook for the convergence processes require more study before their implications can be drawn.

Table 7. The Price-Income Link in Asia Outside Japan

	(1)	(2)	(3)	(4)	(5)	(6)
lnY	0.362		0.344	0.316	0.311	0.268
	(4.89)		(6.53)	(6.22)	(6.16)	(4.86)
INT	-0.096		-0.148		-0.208	
	(0.72)		(1.59)		(2.38)	
IHO		-0.554		-0.279		0.329
		(5.74)		(3.56)		(4.61)
IIN		-1.062		-0.210		-0.347
		(6.75)		(1.28)		(1.94)
IKO		-0.767		-0.166		-0.238
		(6.13)		(1.49)		(1.92)
IMA		-0.693		-0.191		-0.273
		(18.5)		(2.19)		(2.81)
IMA		-0.885		-0.211		-0.322
		(10.4)		(1.80)		(2.18)
IPH		-0.364		-0.040		-0.099
		(4.65)		(0.63)		(1.32)
ITA		-0.548		-0.012		-0.092
		(5.47)		(0.12)		(0.89)
ITH		-1.024		-0.351		-0.468
		(17.8)		(3.14)		(3.79)
R^2	0.77	0.53	0.41	0.82	0.17	0.48
SEE	0.12	1.07	0.88	1.07	0.96	0.80
RHO		0.62	0.73	0.36	0.88	0.76

Note: See Table 5 for a description of reported variables.

APPENDIX 1 — DATA

All data are from Summers and Heston (1988), who generate time-series estimates for PPP-adjusted real income for 130 countries from 1955 to 1980. Since Indonesia only has data for the period 1962-1985, we have restricted our sample to this period.

Our primary data are for:

Y — real per capita GDP in 1980 U.S. dollars, as adjusted by purchasing power parities.

I — investment as a fraction of GDP, based on 1980 'international prices' rather than current prices, and P — GDP price levels relative to the U.S.A. (US=100). This is equivalent to the ratio of the PPP to the market exchange rate times 100.

Data for Y and I are equal to observed values for countries with 1980 benchmarks and to 'smoothed' or extrapolated values for those with several or different benchmark years. Other values are derived by extrapolating from 1980 based on national accounts growth rates for the given variables.

For constructing cross-section and triennial averages, we take arithmetic averages of data as they appear in the regression. For logarithmic variables, this corresponds to geometric averaging of the levels.

APPENDIX 2 — DERIVING THE LEVEL OF PRODUCTIVITY

We assume a Cobb-Douglas production function:

$$Y_t = AK_t^a(L_te^{rt})^{1-a}$$

where Y_t = output at time t,

K_t = capital input at time t,

L_t = labour input at time t,

a = the income share of capital,

r = the Harrod-neutral growth rate of labour productivity, and

A = a constant.

Taking logarithms gives

$$\ln Y_t = a \ln K_t + (1-a) \ln L_t + \ln A + (1-a)rt$$

$$= a \ln(K/Y)_t + a \ln Y_t + (1-a) \ln L_t + \ln A + (1-a)rt$$

$$(1-a) \ln(Y/L)_t - a \ln(K/Y)_t = \ln A + (1-a)rt = p_t$$

where p_t = the level of productivity.

Based on industrial country figures used in Helliwell and Chung (1990a), we assume a=0.2 as a typical value for industrial countries. Having data for (Y/L) but not for (K/L), we generate the latter beginning with the equation:

$$K_t = I_t + (1-d)K_{t-1}$$

where I_t = investment at time t and 'd' is the proportional rate of depreciation. Since

$$(K/Y)_t = (I/Y)_t + (1-d)(Y_{t-1}/Y_t)(K/Y)_{t-1}$$

a capital-output ratio series is generated by combining observed income growth and investment rates with an assumed initial capital-output ratio and depreciation rate.

ENDNOTES

1. Rostow (1978) introduced the 'take-off' notion, and he and others have emphasized the difficulty of finding non-circular ways of defining the conditions necessary to support take-off. Ambramovitz (1986) has emphasized the importance of schooling combined with evidence about the extent of political and social adaptability. Rauch (1989) suggests a simple operational definition embracing all countries with illiteracy rates below 5 per cent.
2. For a recent survey of empirical evidence, see MacDonald (1988).
3. What this expression means is that they are not shipped from country to country in the usual way. They do enter trade in important ways, however, either by foreign consumers coming to collect them (e.g. skiing trips to Whistler) or by being used to facilitate the production of some other product that is traded in the conventional way.
4. For more recent and similar results, see Kravis and Lipsey (1988). An alternative explanation by Bhagwati (1984) rests on incomplete specialization within a Heckscher-Ohlin setting.
5. The data are described more fully in Appendix 1. For the cross-section data, lagged income is equal to 1962 income. For the cross-section data, we use the ordinary least squares regression method. For pooled samples, we use the Zellner procedure to allow for heteroskedasticity of the errors as between countries and autocorrelation of errors within country samples, with the autocorrelation co-efficient constrained to be the same for each country.
6. We use the logarithmic first-difference of this productivity measure times 100 as our measure of the growth rate. The details of our complete derivation are presented in Appendix 2.
7. However, experiments by Helliwell and Chung (1990a) using data from a larger sample of industrial countries provide evidence of convergence to levels below that in the United States, suggesting that both sets of results should be treated with some caution.

BIBLIOGRAPHY

Abramovitz, M. (1986), "Catching Up, Forging Ahead, and Falling Behind". *Journal of Economic History* 46, pp. 385-406.

Balassa, B. (1964), "The Purchasing Power Parity Doctrine: A Reappraisal". *Journal of Political Economy* 72, pp. 584-96.

Bhagwati, J. (1984), "Why Are Services Cheaper in the Poor Countries?" *Economic Journal* 94, pp. 279-86.

Blades, D. and D. Roberts (1987), "A Note On The New OECD Benchmark Purchasing Power Parities for 1985". *OECD Economic Studies* 9, Autumn, pp. 183-97.

DeLong, J.B. (1988), "Productivity Growth, Convergence, and Welfare: Comment". *American Economic Review* 78, No. 5, December, pp. 1138-54.

Helliwell, J.F. and A. Chung (1989), "Aggregate Productivity and Growth in an International Comparative Setting". The University of British Columbia, processed.

_____ (1990a), "Macroeconomic Convergence: International Transmission of Growth and Technical Progress", NBER Working Paper #3264, February.

_____ (1990b), "Globalization, Convergence, and the Prospects for Economic Growth". Department of Economics, The University of British Columbia, Discussion Paper No. 90-06, March.

Heston, A. and R. Summers (1988), "What We Have Learned About Prices and Quantities From International Comparisons: 1987". *American Economic Review* 78, No. 2, May, pp. 467-73.

Hill, P. (1984), "Real Gross Product in OECD Countries and Associated Purchasing Power Parities", OECD Economics and Statistics Department, Working Paper No. 17, December.

Kravis, I.B., A. Heston and R. Summers (1982), *World Product and Income*. Baltimore: The Johns Hopkins University Press.

_____ and R.E. Lipsey (1988), "National Price Levels and the Prices of Tradables and Nontradables". *American Economic Review* 78, No. 2, May, pp. 474-78.

MacDonald, R. (1988), *Floating Exchange Rates: Theories and Evidence*. London: Unwin Hyman.

Rauch, J.E. (1989), "The Question of International Convergence of Per Capita Consumption: An Euler Equation Approach". NBER Summer Institute Paper, August.

Rostow, W.W. (1978), *The World Economy: History and Prospect*. Austin: University of Texas Press.

Summers, R. and A. Heston (1988), "A New Set of International Comparisons of Real Product and Prices: Estimates for 130 Countries 1950-1985". *Review of Income and Wealth*, March, p. 34.

PAUL M. EVANS*

Canada and Taiwan: A Forty-Year Survey†

"The question of the future of Taiwan is a matter for the future to decide."
Mitchell Sharp in the House of Commons,
22 September 1971

The political relationship between Canada and Taiwan has never been warm or close. For Canadian policy-makers, The Republic of China on Taiwan has for forty years generated a run of complicated and often unsettling diplomatic problems. Questions of its legal status and strategic importance have produced controversy in Canada, provoked conflict between Ottawa and Washington, and threatened various Canadian goals in East Asia. Above all, Taiwan has most often appeared to Canadian officials as a perennial obstacle to improved Canadian relations with mainland China.[1]

Substantive bilateral contact has extended over more than a century and a quarter but has never been intensive. The intensity level has begun to rise in the last decade, propelled by the dynamism of the Taiwanese economy, the increasing democratization of its political system, and outflows from it in the forms of trade, investment, tourism and emigration. For the first time, the volume of substantive relations is now such that diplomatic calculations must take into account, first, a positive Canadian interest in Taiwan and, second, the views of an increasingly large and vocal domestic constituency concerned with Taiwan's future.

My objective is to examine the history of Canadian contact with Taiwan and to offer an assessment of the forces that currently shape it. I will try to do so by detaching, so far as possible, "Taiwan" from both its Nationalist Government and mainland China. This is not to make a political point about the virtues or perils of Taiwanese independence. Rather, it is to highlight the dynamics of Canada'a connection with the island of Taiwan as compared to

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the broader diplomatic and ideological issues of the unended Chinese civil war. Government policy and academic thinking in Canada have focused too much on Taiwan as a parergon to a larger interest in China. An interesting pattern emerges when Taiwan is advanced to centre stage.

1871-1949, FIRST CONTACTS

The mission movement represented the first important Canadian connection. In 1871, sixteen years before Taiwan shifted from prefectural to provincial status in the Ch'ing state, and well in advance of Canadian traders and diplomats, Presbyterian missionaries from Canada began arriving on the island. George Leslie MacKay (1844-1901), the best known of the Canadian missionaries, combined evangelism, medical pioneering, and educational reform between 1872 and 1901. Less celebrated in Canada than a Norman Bethune or a Robert McClure, he is well remembered in his adopted home. The current President of the Republic of China, Lee Teng-hui, is an alumnus of a school that MacKay founded.[2]

The Protestant and, later, Catholic missionary presence from Canada spanned the years of Japanese colonial rule between 1895-1945 and the reclamation of Taiwan by the Nationalist Chinese Government. The influence of the missionaries on Taiwanese society and on Canada deserves further research. At home, they made an impression on policy-makers in Ottawa on at least two occasions, first during their reporting of the violent suppression of Taiwanese protest by the Nationalists in 1947 and then as a lobby against Canadian recognition of Peking during the first years of Communist rule.[3]

Trade relations and immigration were minimal until the 1960s. At the diplomatic level, Taiwan drew very little attention from Canadian officials until the late 1940s. Prior to World War II it was the responsibility of the Canadian Legation in Tokyo. Canada recognized the Nationalist Government of "The Republic of China" (ROC), led by General Chiang Kai-shek, in December 1928.[4] Agreement was reached in August 1941 to exchange diplomatic representatives. The ROC established an Embassy in Ottawa and a Consulate in Vancouver in 1942, but Canada delayed creating a legation in Chungking, China's wartime capital, until 1943. This was upgraded to a full Embassy a year later. Between 1943 and 1947 Canada provided the Nationalist government with about $100 million in aid, most of it for military equipment. As late as 1947, the Canadian Cabinet approved the sale of 174 Mosquito bombers to the Nationalist government. It would be unwise, however, to overestimate the degree of Canadian commitment to the Nationalist government, especially after the failure of the Marshall Mission in 1946. As others have argued, Canadian assistance to the ROC was based on domestic concerns rather than admiration for Chiang's government, confidence in its long-term prospects, or a commitment to the cause of anti-communism. In most areas of China diplomacy, Canada was committed to maintaining a hands-off policy in the civil war.[5]

General Victor Odlum, the first Canadian Ambassador in Chungking, was unusual in his deep admiration of Chiang Kai-shek and the accomplishments of the Nationalist government. Odlum stood as one of the very few Canadians who developed an emotional involvement with the Nationalist cause along the lines of several Americans in wartime China. His successor, T.C. Davis, the other diplomats at the Embassy, and most other foreign observers took a different view. As the war with Japan ended and the civil war with the Communists resumed, the despatches from the field were hardly encouraging about the Nationalist's prospects or worthiness. When the ROC government evacuated Nanking in January 1949, Ambassador Davis declined the invitation to join it in Canton and instead returned to Canada leaving a small staff to await the arrival of the Communists.[6]

1949-1968, THE REPUBLIC OF CHINA ON TAIWAN

Few thought it likely that the remnant Nationalist forces which retreated to Taiwan would long resist Communist invasion. Canada continued to recognize Nationalist Government as the *de jure* government of China. It also supported the continuation of Nationalist, rather than Communist representation, at the United Nations and most other international organizations.[7] In the circumstances of late 1949 and early 1950, this support of the ROC seemed simply a temporary arrangement until relations were normalized with the government that was in effective control of mainland China. With the outbreak of the Korean War, the entire picture changed. The initial hesitation and the ensuing saga of Canadian uncertainties, delays, and hesitation in its policy toward the People's Republic of China have been carefully examined elsewhere.[8] Suffice it to say that the "temporary arrangement" held firm for more than twenty years.

The legal status of the island of Taiwan was a contentious issue from the outset. The Cairo and Postsdam declarations of 1943 and 1945 indicated that Taiwan would be returned to China at the end of the war with Japan. The Japanese Peace Treaty, signed in San Francisco in 1951, and the separate Peace Treaty between Japan and the ROC signed in 1952, required Japan to renounce sovereignty over Taiwan but did not transfer sovereignty to any state. By the middle of 1950 Ottawa took the position that the status of Taiwan was not clearly established by earlier declarations and should be settled at an international conference or by the United Nations. This implied that the status of the island was an international issue rather than a strictly Chinese one. This legal opinion conformed with the desire of the St-Laurent government to avoid entanglement in the Chinese civil war and, at the same time, endorsement of Peking's claim to Taiwan. Although the rhetoric differed somewhat during the Diefenbaker era, this line of thinking on Taiwan as *terra nullius* was consistent until the 1970s.[9]

Canadian and American thinking differed on several fundamental points, among them the legal status of Taiwan and the appropriate response to the Communist government on the mainland. On the central issue of diplomatic

recognition, the issue in Canada between 1949 and 1970 was how and when to recognize Peking not whether this should be done. In contrast to the prevailing attitude in the United States, support for Chiang's "Free China" and the strategy of militarily containing and diplomatically and economically isolating Communist China was not widespread or pervasive in Canada. In the minds and hearts of most officials and political leaders, the commitment to the government and cause of the ROC was fragile and temporary.

The Republic of China on Taiwan was a pressing concern for other reasons as well. The conflict across the Straits of Taiwan threatened cherished Canadian aspirations for regional peace and stability and brought Ottawa into public disagreement with Washington. In 1950 Canada supported the American "neutralization" of Taiwan, achieved by inserting the Seventh Fleet into the Straits, but only to prevent an extension of the Korean War. Lester Pearson, then the Secretary of State for External Affairs, stated in the House of Commons that "Canadian obligations do not include the restoration of the Nationalist Chinese Government to the mainland of China or intervention in the Chinese Civil War because of the situation in Korea". The next year he noted that while he agreed that the neutralization of Formosa was valuable for the duration of the Korean War, "It does not follow...that if and when the Korean conflict can be ended satisfactory, we should refuse to discuss the future of Formosa within the context of international agreements that have already been reached concerning it". A week later he added that the interpretation of these agreements should be left to an appropriate body established by the U.N. which would include representatives of the U.K., the U.S.A., the U.S.S.R. and the PRC. Conspicuously absent, it should be noted, was inclusion of the ROC as one of the parties that should be involved.[10]

The most direct conflict with Washington was over the off-shore islands crises in 1954-55.[11] Pearson repeatedly stated that Canada did not support the Nationalist claims over Quemoy and Matsu just off the China coast which were, he claimed, "indisputably part of the territory of China [PRC]".[12] He supported the view that it was important, if not vital, to Western interests to keep Taiwan from falling into Communist hands. But Canada, he emphasized, accepted no commitment, except through normal obligations to the United Nations, to "share in the defence of either Formosa or the coastal islands, or to intervene in any struggle between the two Chinese Governments for possession of the Off-shore islands".[13]

Bilateral political contacts between Canada and the ROC were not strong. Canada did not give military or developmental assistance to the ROC after 1947. The ROC maintained an Embassy and Consulate in Canada, but successive Canadian govenments refused to establish a diplomatic presence in Taiwan, instead handling consular and commercial affairs from Hong Kong. This symbolized the fragility of the Canadian commmitment to Chiang's regime and ensured that there would be no regular diplomatic monitoring of the situation in Taiwan. The prospects of other Canadian diplomats "going native" in Odlumesque style were nil.

The ROC Embassy in Ottawa, located in the gracious mansion which had once been the home of Sir Robert Borden, faced an uphill battle. There was very little activity in trade, investment, travel or immigration. After the restructuring of the Taiwanese economy towards export-oriented industrialization in the early 1960s, two-way trade did pick up, but only reached the $50 million mark in 1968. Nor did the Embasssy have the resources enjoyed by its diplomatic representatives in the United States. Most importantly, it lacked influential Canadian supporters. There was no equivalent to the "China Lobby" that promoted the ROC cause in the United States.[14] It is not surprising that one of the ROC Ambassadors to Canada in the 1950s spent more time in Washington than Ottawa.

In the absence of substantive relations, the ROC's only real option was to present itself as a symbol of freedom and anti-communism. Canadians did not prove to be a receptive audience. Opinion in Canada was divided but generally negative about Nationalist China. Chiang's Government had its avid supporters, especially among Conservatives and Socreds and in the small Chinese Canadian community. But to most Canadians inside and outside of government, the cause of "Free China" was alien and largely unconvincing. The dominant images of the Nationalist Government were those that had been created in the 1940s on the mainland. Chiang himself was most often identified with corruption and repression. There were viturally no informed references to the experience of the Nationalists on Taiwan after 1949.[15]

Ottawa's commitment in the 1950s and 1960s was to the people of Taiwan, not the Nationalist Government. Canadian officials frequently expressed the sentiment that no settlement of the status of Taiwan could be arrived at without taking into account the views of the people themselves. As Secretary of State, Pearson observed in February 1953 that "In any decision regarding the future of Formosa, the wishes of the people there would naturally be a primary consideration". A decade later, as Prime Minister, he stated that his government, like the Diefenbaker government that preceded it, "would be quite wrong to accept the authority by recognition of the Communist goverment in Peking over Formosa without the consent of the people of Formosa".[16]

This disposition toward "the people" of Taiwan needs some explanation. At one point in 1951, Pearson coyly suggested that if the people of Taiwan were allowed to voice their opinion, "I do not know what they would decide ... I suspect, however, that their decision might be a surprising one". A few months later he went further and observed that the Taiwanese "are a people who have not known national freedom, and who are in many ways separate from the Japanese and Chinese who have ruled over them".[17] Aside from these two vague but suggestive hints about Taiwanese independence, very rarely did Governmental or Parliamentary comment on the "people of Taiwan" dig beneath the surface to examine the prospects of the Taiwanese independence movement. On the issue of independence, as on other Taiwanese political developments, the level of discussion and analysis was more symbolic than substantive.

The commitment to self-determination was grounded in two sets of concerns. One was legalistic and abstract, springing from the general objectives Pearson and others had staked out at the United Nations. The second was more visceral: a widespead abhorrence of seeing Taiwan subjected to Communist rule. Together they provided the context for innumerable efforts in the 1950s and 1960s to find a way to move ahead with relations with the PRC while preserving a separate, if not independent, Taiwan. For fifteen years Canadian diplomats laboured at creating the perfect formula, all variants on "Two Chinas", "One China, One Taiwan", which would solve the riddle. All foundered because of resistance from Washington and, more importantly, because of obdurate opposition from Taipei and Peking which both agreed that Taiwan was an inalienable part of China. The depth of this opposition and its dynamics, especially pertaining to the mandate of Nationalist rule within Taiwan, were never fully appreciated in Ottawa.

1968-1983, CLOSING THE DOOR

With the rise of Pierre Trudeau came the long awaited realignment of China policy. The old problem of Taiwan did not magically disappear. From the outset, Trudeau indicated that preserving Taiwan would be an important objective. In May 1968, he stated that "The PRC would probably say no unless we agreed to break relations with Taiwan. We wouldn't do that." Later that month he reiterated the importance of bringing mainland China into the world community, enhancing Canada's commercial relationship with it, and reducing tensions between China and other countries, especially the United States. "Our aim", he concluded, "will be as soon as possible to recognize the People's Republic of China and to enable that government to occupy the seat of China in the U.N., taking into account that there is a separate government in Taiwan." Later he added that "I hope we can bring about a situation in which the existence of a separate government in Taiwan is recognized and that we can, at the same time, recognize that the PRC government is effectively in control of the mainland area".[18]

His intentions concerning Taiwan angered Taipei, raised hackles in Peking, and posed a formidable challenge to the officials entrusted with implementing the Prime Minister's policy. In the fall of 1968, DEA proposed a formula under which Canada would recognize the PRC as the only government of China without necessarily accepting China's territorial claims over areas in which it did not exercise jurisdiction. This did not amount to recognition of Taiwan as an independent state but left open the possibility of the Taiwan government maintaining a trade office in Canada which would facilitate dealings in matters of mutual interest. At a Cabinet Committee meeting of 27 January 1969, the recommendation on Taiwan was amended to state that Canada would not accept any commitment that would preclude Canadian recognition of an independent state of Taiwan if that were at all feasible. Soon thereafter the Embassy in Washington was instructed to inform the State Department of these changes in Canadian policy and to offer reassurances that Canada planned to

continue good relations with Taiwan even if formal diplomatic relations were broken. Ottawa would break off negotiations with Peking rather than being forced to sever all links to Taiwan or endorse Peking's claim to Taiwan.

During the twenty months of negotiations in Stockholm, Canadian and Chinese negotiators clashed repeatedly on the issue of Peking's demand that Taiwan be recognized as "an inalienable part of Chinese territory". The Chinese insisted that the Sino-French model of 1964, which did not raise the issue of Taiwan, was inappropriate. By the middle of 1969, Ottawa had abandoned any hope of securing a "One China, One Taiwan" arrangement, instead admitting that it would be forced to withdraw recognition from Taipei, although without accepting the PRC's territorial or political claim to Taiwan.

So it came to pass. On 10 October 1970, ironically the national day of the Republic of China, the joint communique was signed establishing relations between Canada and the PRC. Three days later it was formally announced. The future status of Taiwan was left somewhat ambiguous. Paragraphs two and three read as follows:

> The Chinese Government reaffirms that Taiwan is an inalienable part of the territory of the People's Republic of China. The Canadian Government takes note of this position of the Chinese Government.
>
> The Canadian Government recognizes the Government of the People's Republic of China as the sole legal government of China.

The actual terms of the communique on the sovereignty issue were not substantially different than those later negotiated with the PRC by the United States and other governments. The minimum price was acknowledgement of at least the PRC's claims of sovereignty over Taiwan. In that sense, the "sacrifice" of Taiwan during the Stockholm negotiations was no greater than what was unavoidable.

The Canadian approach to Taiwan had three distinguishing features through most of the Trudeau years. First, the provisions of the "One-China" policy were interpreted narrowly and enforced meticulously. Ottawa moved quickly to support PRC representation in and ROC removal from almost all international organizations, especially the United Nations. In bilateral affairs, all ROC offices in Canada were closed; official or government-to-government contacts were forbidden; government programs and services were not to be extended to Taiwan; Taiwanese were not permitted to enter Canada for official or political purposes; and federal ministers and officials were forbidden to travel to Taiwan.

Second, with the shift of policy came a shift of attitude. If the initial intentions of the Trudeau Government had been to find a way to maintain relations with Taiwan, the implementation of the policy moved in exactly the opposite direction. Legalism prevailed over pragmatism. The Republic of China was not only out of season but out of bounds, a pariah state. Its diplomats and officials were scrupulously avoided. Whether intentional or not, Canadian

officials tended towards indifference, distrust and occasional condescension in their treatment of ROC citizens. The attitude was particularly resented by Taiwanese business people, especially when dealing with visa and immigration issues.[19]

Third, and most important, no provisions were made for informal or unofficial relations with Taiwan. A few days before the signing of the Stockholm communique, the ROC Ambassador to Ottawa raised the possibility of maintaining a representative in Canada in a "private" capacity to take care of consular matters such as the issuance of visas and "related questions". The suggestion was politely refused and led to an equally polite response from the Ambassador which criticized the impending Canadian move and expressed the hope that the break in diplomatic relations "does not impair the friendship that exists between the people of the two countries". At the same time, A.E. Ritchie, the Under-Secretary of State for External Affairs, indicated in a private memo that a temporary protocol office would be established to handle the sensitive problems of "de-recognition" and added that while a complete break with the Nationalist Chinese was desirable, "it is clear that we cannot and will not wish to sever all contacts with them". His intention was soon to create an "inter-departmental body made up of representatives of departments and agencies with continuing interests in Taiwan to study and coordinate future unofficial relations with the Taiwanese".[20]

Ritchie's plans never materialized and a regularized "unofficial" institutional channel for the management of relations was not put in place for more than fifteen years. Consular matters such as the issuance of visas were still handled from the Commission in Hong Kong and trade matters from the Embassy in Manila. Conversely, the Coordination Council for North American Affairs in Washington took responsibility for consular and commercial relations with interested Canadian parties. Mechanisms were established for conducting *ad hoc* discussions in third countries, usually the United States, on subjects of bilateral concern such as voluntary export agreements. These did not always work well. An unofficial meeting between Canadian and ROC officials in Washington in June 1972 was expected to be in confidence, but received coverage in several newspapers in Taiwan, thereby embarrassing Canadian officials and making future discussions more difficult. The pattern was repeated in November 1988 and in this instance led to a formal PRC protest.[21]

The Canadian approach contrasted markedly to what later emerged when the United States broke formal relations with the Republic of China. In the PRC-USA communique of 1 January 1979, Washington was able to insert a phrase that stated "the people of the United States will maintain cultural, commercial, and other unofficial relations with the people of Taiwan". A few months later, on 10 April 1979, President Carter signed into law the Taiwan Relations Act (P.L. 96-8) which created domestic legal authority for the conduct of a full range of economic and social relations with the people of Taiwan through the unofficial American Institute in Taiwan which, with a staff of more than 250, could accept visa and passport applications and provide

assistance to U.S. citizens. Conversely, Taiwan's representatives in the U.S.A. were granted diplomatic immunity.

Ottawa's "de-recognition" of the ROC was bound to be an unpleasant affair. Taipei bridled at the Canadian action, correctly fearing that the Canadian move would influence other countries to do likewise.[22] The freeze in relations with Taiwan probably reached its coldest point in 1976 over the issue of ROC participation in the Montreal Olympics.

The depth of the bitterness of these years, the sources of Canadian sensitivities, and the inability to construct workable "informal" relations can only be understood by considering two basic factors. The first was that the opening to PRC was such a great success in Canada, generating far more momentum more quickly than had been expected. It was a personnal triumph for the Prime Minister, his personal advisors, his party, and the diplomats who had engineered it. And it was hugely popular, capturing the Canadian imagination as few foreign policy initiatives ever have. The construction of Sino-Canadian relations after 1970 is akin to the creation of the trans-continental railway a century earlier. The Canadian government, motivated by both a dream and pressing realities, created a series of long-distance linkages and was extremely successful in involving the Canadian public in the process.

Canada's relationship with the PRC over the past twenty years has been very carefully managed. It was not so much born as it was created and the investment in its creation was immense. Neither Trudeau nor his advisors wished to jeopardize an expanding and popular relationship with mainland China which was already paying handsome dividends and which promised more in future. The dividends in hand were clear on the trade front, particularly in wheat and potash; those to follow, on both the economic and geo-strategic fronts, were at least as tempting.[23]

Second, the domestic base of support for relations with Taiwan was weak. Put bluntly, very few Canadians had a personal stake in Taiwan's fate. Surprisingly, support for the ROC in the Chinese Canadian community was, after the recognition of the PRC, divided and weak.[24] With the exception of a few backbench and opposition MPs and a handful of journalists, few in the policy elite had visited Taiwan. Government officials were forbidden to do so. This was further reinforced by Ottawa's unwillingness to encourage private contacts. Contact with Taiwan came almost to be a badge of marginality. Twenty years of Canadian policy had ensured that almost no one in top government positions had deep personal familiarity with Taiwan. There thus was no internal constituency within government with a major interest in promoting bilateral contacts. Policy reinforced history.

POST 1983, DISCOVERING TAIWAN

Ironically, the termination of diplomatic relations with the ROC coincided with a rapid escalation in private Canadian contact with Taiwan. Trade has been the key link. If the Canadian government has been the main player in relations with the PRC, private importers and, later, exporters have been at the

center of relations with Taiwan. In 1970 total two-way trade was less than $70 million; in 1989 it exceeded $3.2 billion, making Taiwan Canada's seventh largest trading partner. (See Table 1)

Table 1. Canada's Trade With The PRC and ROC/Taiwan, 1968-1989

Year	Imports From Prc	Exports To Prc	Trade Balance	Imports From Roc	Exports To Roc	Trade Balance
1968	23,439	163,243	139,804	34,379	16,893	-17,486
1969	27,421	122,891	95,470	42,456	12,157	-30,299
1970	19,028	141,995	122,967	51,936	18,315	-33,261
1971	23,302	204,061	180,759	80,706	14,140	-66,566
1972	48,377	263,639	215,262	126,186	25,829	-100,357
1973	52,904	287,986	235,082	163,763	34,307	-129,456
1974	61,439	438,967	377,618	193,758	42,694	-151,064
1975	56,328	377,260	320,932	292,589	38,813	-253,776
1976	88,368	196,525	108,157	292,540	43,106	-249,434
1977	82,154	369,270	287,116	320,700	73,953	-246,747
1978	94,599	504,012	409,413	397,186	103,211	-293,975
1979	167,451	605,434	437,983	522,065	105,477	-416,588
1980	155,087	873,663	718,576	557,635	253,854	-303,781
1981	220,013	1,019,556	799,543	729,142	236,996	-492,146
1982	203,654	1,232,070	1,028,416	661,268	304,730	-356,538
1983	245,772	1,608,479	1,362,707	925,496	344,721	-580,775
1984	333,502	1,242,880	909,378	1,223,800	429,536	-794,264
1985	403,475	1,296,779	893,304	1,286,167	433,722	-852,445
1986	593,716	1,118,968	525,252	1,876,991	611,409	-1,265,582
1987	812,229	1,432,079	619,850	2,166,115	757,022	-1,409,093
1988	955,357	2,593,135	1,637,778	2,257,478	967,425	-1,290,053
1989	1,182,291	1,120,017	-62,274	2,351,381	882,350	-1,469,031

Source: External Affairs and International Trade Canada, Ottawa

In the face of a significant trade imbalance in its favour, the Taiwanese side had a stronger interest in promoting commercial relations. In 1974, the Far Eastern Trade Service, representing what is now the China External Trade Development Council, opened an office in Toronto. A small trade mission from Taiwan visited Canada in 1979. In 1980 the Chung Hua Chamber of Commerce opened an office in Canada. A larger and higher profile trade delegation made a second visit to Canada in November 1983.[25]

From the Canadian side, interest and concerted action came somewhat later. A change of thinking was apparent by March of 1984 when the Pacific

Basin Economic Council held its meetings in Vancouver and a Taiwanese delegation was permitted to attend. In November of 1984, a flag-bearing ship of the China Steel Corporation docked in Vancouver. Two years later, after a lengthy debate on its title, Taiwan was admitted to the Pacific Economic Cooperation Conference as "China-Taipei" and attend the meetings held in Vancouver. At about the same time, exporters to Taiwan became eligible for the government programs (e.g. Program for Export Market Development and National Trade Strategy Projects) that they received when doing business elsewhere in Asia. This represented a quiet but significant shift in the government's interpretation of the "One China" principle.

By far the most important Canadian initiative was the opening of the Canadian Trade Office in Taipei in 1986. This had been a major objective of several M.P.s and Canadian exporters since the early 1970s. By the mid-1980s the idea had achieved widespread support.[26] It had been reviewed on numerous occasions but did not attract major consideration by the Canadian government until late 1983. In May 1984, a proposal was put to Cabinet for funding through the mechanism of an annual grant for the encouragement of overseas trade development to the Canadian Chamber of Commerce. Without signalling any change of policy, the office was intended to assist Canadian business in gaining access to a potentially lucrative market, reducing a three-to-one trade deficit, and keeping pace with similar offices run by OECD partners including the United States, Japan, U.K., France, Germany, Austria, Denmark, Spain and Australia. Estimates indicated that the office might improve Canadian exports up to 10 per cent, a not insignificant figure considering the extent of the Canadian trade deficit. Late in 1990 the office was expanded to include a travel facilitation service for visa applicants, an education advisor, and a commerical officer specializing in tourism promotion.[27]

Canadian business representation had grown quickly. All five major Canadian banks established offices in Taipei. Four provinces operate trade offices. Direct airlinks between Taiwan and Canada began in December 1990, and already the traffic between Taipei and Vancouver is on a strong commercial basis. At the level of people-to-people relations, there has been a modest growth of activity along the lines of joint academic conferences and projects, twinning relationships, and student exchanges. Immigration to Canada has increased steadily in the 1980s and jumped dramatically in 1988 and 1989. (See Graph 1 and Table 2.)

Canada is a comparative late comer to the "peek-a-boo diplomacy" of finding ways to advance contact with Taiwan without offending Peking. The Canadian approach has involved frequent consultation with PRC officials and a generally low-key, low-profile style. Since 1986 Ottawa has shown an attitude of flexibility and creativity unthinkable only five years earlier. Taiwan is increasingly viewed as an opportunity rather than an obstacle.

Bilateral irritants have been reduced but not eliminated. Visa issuance was a recurrent problem until 1991. There have been public clashes over Taiwanese journalists in Ottawa, the potential sale of CANDU reactors to Taiwan, the expulsion of a Taiwanese trade representative in February 1986, another

Graph 1

Annual Immigration to Canada: PRC, Hong Kong, Taiwan 1968 - 1989

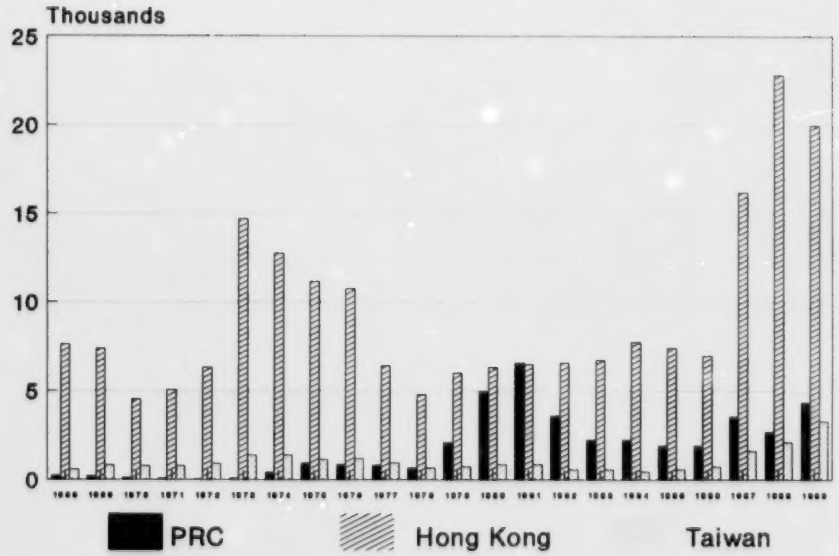


Table 2. Annual Immigration To Canada: PRC, Hong Kong, Taiwan

YEAR	PRC	HONG KONG	TAIWAN
1968	231	7,611	556
1969	180	7,342	789
1970	121	4,508	746
1971	47	5,009	761
1972	25	6,297	859
1973	60	14,662	1,372
1974	379	12,704	1,382
1975	903	11,132	1,131
1976	833	10,725	1,178
1977	798	6,371	899
1978	644	4,740	637
1979	2,056	5,966	707
1980	4,936	6,309	827
1981	6,550	6,451	834
1982	3,571	6,542	560
1983	2,217	6,710	570
1984	2,214	7,696	421
1985	1,883	7,380	536
1986	1,902	6,940	695
1987	3,534	16,170	1,590
1988	2,669	22,802	2,089
1989	4,333	19,981	3,260

Sources: External Affairs and International Trade Canada, Ottawa; Employment and Immigration Canada.

instance of a confidential meeting between ROC and Canadian officials being disclosed in Taipei in December 1988, and the treatment of a Canadian supporter of a Taiwanese independence party who was arrested in Taiwan in 1989.[28]

THE NEW BILATERAL AGENDA

In looking at the 1990s, the main lines of Canada's "One China" policy are not destined for change. But substantive relations with Taiwan will continue to expand and already include direct air links and expanded representative offices. The main axis will certainly be commercial. Canada lacks the interest and the capabilities to play any positive role in the security balance affecting Taiwan and PRC, except, in Pearsonian style, as an international citizen with a general stake in regional peace and stability. Similarly, on the large political

issues of Taiwan's representation in international organizations such as the GATT, and the Asian Development Bank and APEC, there are reasons to favour inclusion of Taiwan but not to play a major role in promoting it.

The future of the bilateral relationship is likely to be shaped by four factors: the Taiwanese economy; the Taiwanese polity; relations across the Straits of Taiwan; and the domestic political environment in Canada.

The Taiwanese Economy

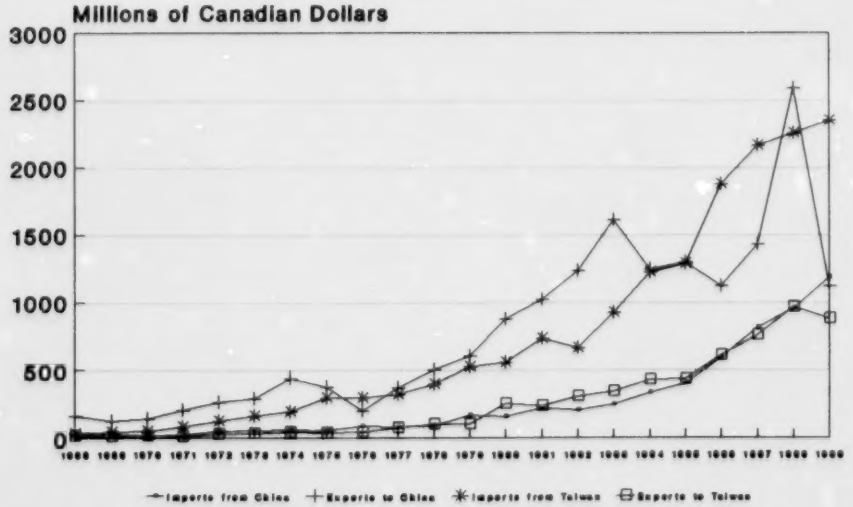
America's intervention in the Chinese civil war might have been a policy error in 1950 in Ottawa's eyes, but it produced a rather spectacular success story within twenty years. The emergence of Taiwan as a vigorous, industrialized, export-oriented economy has been much celebrated and documented.[29] It is now the world's twelfth largest trading state; its annual growth rate averaged more than 8 per cent in the 1980s; per capita annual income has reached approximately $8,000, and is fairly evenly distributed creating a large middle class; its combined annual trade surpluses in the 1980s exceeded CDN $100 billion despite a 40 per cent increase in the value of its currency since 1987. Its GNP is now roughly one-third that of the PRC which has a population fifty times larger.

As important as growth, the structure of the economy and its position in the global economy have shifted in several important ways. Taiwan's export pattern is changing, both in composition of exports and locale. Higher value added manufactured goods are playing an increasingly large role, the result of a vigorous restructuring of manufacturing. Of equal significance, trade with other Asian countries is expanding faster than cross-Pacific trade. Correspondingly, the share of exports sent to the United States, while still large, has dropped from about 50 per cent in 1985 to 36 per cent in 1989. In terms of foreign investment, Taiwan is now a significant exporter of capital. Some of the outflow has been directed at the European and North American destinations as seen in the acquisition of Wyse Electronics, based in California, for $300 million. In 1989, its direct foreign investment in Eastern Asia exceeded $4 billion, principally to relocate production in lower wage countries. This made Taiwan a much larger player in the shifting international political economy of Eastern Asia.[30]

The implications for Canada of these shifts is a complicated issue. The most glaring fact is a persistent and large trade deficit which in 1989 exceeded $1.5 billion (see Graph 2). Although the comparative size of the deficits is similar, this is less significant a problem for Canada than the United States because of a generally more favourable balance with other Asian countries, particularly Japan. There is of course a case to be made for redoubling efforts to crack into expanding markets in Taiwan. The ability of Canadian companies, especially in manufacturing, to compete effectively in the rapidly changing regional economy of Eastern Asia is a serious question. There are reasons for serious concern about the composition and trends in Canadian trade patterns with Taiwan as well as the other NICs.[31] The crucial political question that warrants much closer attention in future is how far can Canada compete in Taiwan without playing a larger and more visible political role.

Graph 2

Canada's Trade with the PRC and ROC/Taiwan 1968-1989



Source: External Affairs and International Trade Canada, Ottawa

The Taiwanese Polity

Political changes in Taiwan in the past decade, and especially since the lifting of martial law in 1987, have been equally dramatic but have received far less attention. The Kuomintang (KMT) has been responsible for overseeing a transition towards broader participation and the dismantling of single-party authoritarian rule. With the establishment, consolidation and legitimation of a major opposition party, the dramatic expansion of electoral competition, and the internal fragmentation of the Nationalist Party, a new and vibrant form of pluralism is emerging and with it the assertion of a vigorous civil society. The transition to a multi-party electoral system has had its fits and starts and the precise outcome is far from certain. At this point, however, the process of democratization is virtually irreversible.[32]

Democratization brings its own perils. Whatever the direct effects of the decline of the ruling KMT on the growth of the economy, there is clearly rising instability. The underlying causes are many, but one of the most important is Taiwanese independence. The KMT has enjoyed considerable success in its Taiwanizaton program which has substantially altered the compositon of the party and Government. But the deeper problem, highlighted by the rise of the prinicipal opposition party, the Democratic Progressive Party, is the long-term political future of the island. The principal domestic issue is the challenge to the KMT's commitment to reunification with the mainland and, related, the foundation of its mandate to rule. It is unclear whether the KMT has the will and ability to transfer its claim to leadership from its place in Chinese history to the provision of good government.

The China Factor

Closely related is the evolving relationship between Taiwan and the mainland. From a situation of overt hostility and uncompromising opposition in the early 1980s, tensions have been reduced since 1987. ROC citizens are now permitted to visit the mainland, "indirect" trade has reached about $3 billion per year in 1989, and Taiwanese investment in the mainland has been running at about $150 million per month. Reunification and the end of ideological conflict are not imminent. But some observers are sufficiently optimistic, especially about the deepening economic relationship across the Straits, that they see Taiwan as the future gateway to China for Canadian exporters. Whether or not the connections with the mainland prove that strong, these arguments do point to the important prospect of Canadian opportunities in a Taiwan that is an integral part of an emerging regional economy.

One tangible result of reduced tensions is that foreign countries which wish to increase substantive relations with Taiwan while maintaining contact with the PRC have much more room for manoeuvre. Canada, Australia, France, and the U.K., have certainly taken advantage of the opportunity. This latitude has also been enlarged by the ROC strategy of "flexible diplomacy". Flexible diplomacy has occasionally meant head-to-head competititon with Peking for diplomatic relations with Third World states, but it has also emphasized the

value of substantive contacts, primarily economic, which no longer are used primarily as wedges in the quest for more direct diplomatic relations.

The Domestic Context in Canada

Canadian policy toward Asia is largely an elite preserve. The most important single private constituency is business. Concerning China and its periphery, a new constituency is emerging in Canada in the form of the growing number of Chinese Canadians. Between 1970 and 1989, the total number of immigrants from Taiwan, Hong Kong and the PRC has been just under 250,000 (see Table 2). More importantly, Chinese Canadians are becoming increasingly assertive and sophisticated in expressing political demands. Their voice and influence became very clear in the aftermath of the Tiananmen incident in the summer of 1989. The resulting protest was a harbinger of increasing activism which will no doubt be intensified as Hong Kong's 1997 deadline looms closer. Human rights issues and the unification problem will receive much closer scrutiny and attention in Canada than they have in the past.

The Tiananmen incident was significant for another reason. In its aftermath broad public enthusiasm for China has diminished. Further, it crystallized worries in Ottawa and in the business community about the long-term prospect of economic modernization in China. Taken in combination, these changes at the public and governmental levels have unravelled the extraordinary consensus which has supported Canadian relations with China for twenty years. China is still important but it is less special. In practical terms, this break in momentum means that other issues and regions will get more attention. Taiwan will be an obvious beneficiary.

Finally, more linkages with Taiwan through emigration and tourism will bring more contact with the turbulent world of Taiwanese politics. Canada will remain a very small player in the Taiwanese political scene but Taiwanese politics will have increasingly significant repercussions for Canada. For better or worse, Canada's era of innocence in Taiwan, as in China, is at an end.

THE WAY AHEAD

The basic ingredients of an effective and appropriately balanced policy towards both mainland China and Taiwan are now in place. Yet there is room for adjustment. In the near future changes are needed in the structure and operations of the Canadian Trade Office in Taipei, especially its reporting lines to Ottawa. It is also important to expand the level and quality of political and economic coverage of Taiwan through private and governmental channels. It is in Canada's interests for more diplomatic and trade officials to have contact with Taiwan through secondments and language training in Taipei.

The biggest weakness in the current Canadian relationship with Taiwan is its narrow base. Business is a good foundation but various problems arise if it is the exclusive foundation. First, more comprehensive and intensive contact is necessary to sustaining economic objectives. Second, in the not unlikely event of economic ups and downs, a more diversified relationship promotes

long-term stability. The best example of this is the ways in which the extensive interconnection between elites in Taiwan and the United States have helped the two countries weather some very difficult bilateral trade disputes.[33]

What is missing are the cultural, academic and social connections which add depth and sustenance to the business of business. The main actors in forging these connections have been, from the time of the arrival of the Presbyterian missionaries, private institutions. This is unlikely to change. But government has a special role to play in the case of promoting Canada-Taiwan linkages. Funding is not the key issue. Rather, after a very long period of discouraging contact with Taiwan, federal departments and agencies can play a discrete role in legitimizing future contact. This can be done in a variety of ways including national conferences, federally sponsored research projects and exchanges of scholars, the establishment of a Canadian studies program in Taiwan, and assistance to Taiwanese students who wish to come to Canada. this small number of students from Taiwan in Canadian as compared to American institutions is seen in Tables 3 and 4.

Table 3. North American Students in Taiwan by Field of Study, 1987

Field of Study	U.S.A.	Canada
Humanities	1122	95
Other	17	2

Source: *Statistical Yearbook of the Republic of China 1988*

With this encouragement, provincial governments, Canadian universities and colleges, and national organizations such as the Asia Pacific Foundation and the Association of Universities and Colleges of Canada are likely to play more active roles in promoting contacts with Taiwan. The recent establishment of a position for an educational advisor at the Canadian Trade Office in Taipei is an important step forward. Equally important was a meeting of university presidents and education officials from Canada and Taiwan in Kananaskis, Alberta, in May 1991.[34]

It is contact with the people of Taiwan, not high politics, that is now the leading edge of Canadian interest. Canada has so far been very successful in avoiding a definitive stand on Taiwan's future, leaving it instead, as Mitchell Sharp wisely advised, to the future to decide. Until that future arrives, there are modest but important gains to be made by quietly expanding the foundations of substantive contact.

Table 4. Annual Approval of ROC Students to Study in North America

	U.S.A.	Canada
1960	531	10
1961	733	15
1962	1,387	78
1963	1,685	129
1964	2,026	125
1965	1,543	111
1966	1,696	164
1967	2,047	144
1968	2,272	107
1969	3,015	68
1970	1,825	35
1971	2,289	14
1972	1,867	16
1973	1,650	30
1974	1,992	43
1975	1,824	139
1976	3,173	111
1977	3,369	44
1978	4,350	33
1979	5,463	31
1980	5,572	19
198	4,976	19
1982	5,572	12
1983	5,371	10
1984	5,066	9
1985	5,532	9
1986	6,449	11
1987	6,052	13
1988	6,382	15
TOTAL	**95,709**	**1,551**

Source: Ministry of Education, ROC, as quoted in Philip C. Chang, "Education: A Missing Link in Canada-Taiwan Business Relations". Third Annual Meetings of the Canada Taiwan Association, Edmonton, April 1989.

ENDNOTES

1. The terminology is complex and contested. "Formosa" and Taiwan" both refer to the island, the former being coined by the Portuguese and the latter by the Chinese. "The Republic of China on Taiwan" has been used by the Nationalist authorities to perpetuate its claim to be the legitimate government of all China while at the same time recognizing that its effective control has been reduced principally to the island that previously had been the province of Taiwan. Canadian officials used the designation "Republic of China" in formal situations to refer to the Nationalist government between 1928 and 1970, though used "Formosa" or "Taiwan" to refer to the effective area of Nationalist control and the home of the Taiwanese people. Since 1970 they have used "Taiwan" exclusively. The Government in Taipei, of course, continues to refer to itself as either "The Republic of China" or "The Republic of China on Taiwan". For purposes here, I will generally follow current Canadian and American practice and refer to "Taiwan" though I will occasionally use some of the other labels when doing so reduces confusion.
2. See John Geddes, "Canada's Role in the Modernization of Taiwan: The Educational and Medical Work of Dr. George Leslie MacKay and Associates", in Bernard T.K. Joei, ed., *Canada in the Evolving Pacific Community* (Tapei: Tamkang University, 1988); Graeme McDonald, "George Leslie MacKay: Pioneer Canadian Missionary to China", *Papers on China* (Harvard University), vol. 21, 1967; Hamish Ion, "English and Canadian Presbyterians in Taiwan, 1895-1925: A Brief Survey", *Journal of United Reform Church History*, Vol. 2, No. 4 (October 1979); and Murray A. Rubinstein, *The Protestant Community on Modern Taiwan* (Armonk, N.Y.: M.E. Sharpe, 1991.)
3. See Stephen Beecroft, "Canadian Policy Towards China, 1949-1957: The Recognition Problem", in Paul Evans and Bernie Frolic, eds., *Reluctant Adversaries: Canada and the People's Republic of China, 1949-1970* (Toronto: University of Toronto Press, 1991).
4. The terms and process of recognition were both complex and indirect. The issue of recognition arose out of negotiations between the Governments of the United Kingdom and Nationalist China over the question of tariff autonomy in the summer of 1928. In October the Secretary of State for Dominion Affairs in London informed the Secretary of State for External Affairs in Ottawa that conclusion of negotiations on the tariff issue would constitute recognition. Officials in Canada were slow in responding. A telegram was eventually drafted which stated that "His Majesty's Government in Canada agrees to His Majesty's Minister in Peking being authorized to make, on behalf of His Majesty's Government in Canada, a formal communication according recognition of the Chinese National Government and concur in proposed exchange of notes". However, the telegram was never sent. Nor did London ever address a formal communication recognizing the Nationalist Government. The treaty was never-

theless signed and the British Minister immediately presented his credentials to Chiang Kai-shek on 20 December 1928. Although no formal communication had been made, the exchange of notes constituted recognition of the new Government. See "Recognition of Nationalist China", Memo by T.M. Pope, 8 June 1961. File 50055-B-40, Volume 7, PAC, Ottawa.

5. See Kim Richard Nossal, "Business as Usual: Relations with China in the 1940s", in Kim Richard Nossal, ed., *An Acceptance of Paradox: Essays on Canadian Diplomacy in Honour of John W. Holmes* (Toronto: Canadian Institute of International Affairs, 1982). A fuller examination of Canadian policy towards Nationalist China is in *idem*, "Strange Bedfellows: Canada and China in War and Revolution, 1942-1947", Unpublished Ph.D. dissertation, University of Toronto, 1977.
6. Canadian opinion from the Embassy in Chungking (and later Nanking), see Kim Nossal, "Strange Bedfellows", *op. cit.*; *idem* "Chungking Prism: Cognitive Process and Intelligence Failure, *International Journal*, Vol. 32, No. 3 (1977); Chester Ronning, *A Memoir of China in Revolution* (New York: Random House, 1974); Beecroft, "Canadian Policy Towards China," *op. cit.*; and Brian Evans, "Ronning and Recognition: Years of Frustration", in Evans and Frolic, eds., *Reluctant Adversaries*, *op.cit.*.
7. The most thorough account of the origins and development of the Canadian position is in Don Page, "The Representation of China in the United Nations: Canadian Perspectives and Initiatives, 1949-1971", in Evans and Frolic, *Reluctant Adversaries*, *op. cit.*.
8. See John Holmes, "Canada and China: The Dilemmas of a Middle Power", in A.M. Halpern, ed., *Policies Toward China: The Views From Six Continents* (New York: McGraw Hill, 1965); and Evans and Frolic, eds., *Reluctant Adversaries*, *op. cit.*, especially Chs. 1-7.
9. On the background to the Canadian position on the legal status of Taiwan, see Robert W. Reford, *Canada and Three Crises*, (Toronto: CIIA, 1968), pp. 22-27; and *External Affairs*, Vol. 5, No. 4, April 1953. See also USSEA, Memorandum for the Prime Minister, "Recognition of Communist China", 11 June 1958. DEA File 50055-B-40, Vol. 4.
10. The statements were in the House of Commons, 31 August 1950, 7 May 1951, and 14 May 1951.
11. On the offshore islands crises, see Reford, *Canada and Three Crises*, *op. cit.*, pp. 11-72; Donald C. Masters, *Canada in World Affairs, 1953-1955* (Toronto: University of Toronto Press, 1959), pp. 99-110.
12. House of Commons, 25 January 1955.
13. Lester Pearson, SSEA, 25 January and 24 March 1955, House of Commons. See also, Draft Memorandum on China Policy, prepared by Far Eastern Division, 10 February 1956. DEA File 50055-B-40.
14. See Ross Koen, *The China Lobby in American Politics* (New York: Harper and Row, 1974); and Stanley D. Bachrack, *The Committee of One Million:*

"China Lobby" Politics, 1953-1971 (New York: Columbia University Press, 1976).

15. On Canadian images of China and Taiwan, and their connection to policy preferences, see Paul Evans and Daphne Gottlieb Taras, "Looking (Far East): Parliament and Canada-China Relations, 1949-1982", in David Taras, ed., *Parliament and Canadian Foreign Policy* (Toronto: CIIA, 1985); and *idem*, "Canadian Public Opinion on Relations With China: An Analysis of the Existing Survey Research" (Toronto: Joint Centre on Modern East Asia, Working Paper #33, March 1985). On division and debate within the Department of External Affairs, see the essays in *Reluctant Adversaries*, *op. cit.* by Stephen Beecroft, Don Page, Norman St. Amour, and Brian Evans. "Loyal Ally" arguments were less frequent than less positive references. Representative of the flavour of these comments were comments such as those of several CCF/NDP M.P.s who referred to Chiang's government as "undemocratic, reactionary and corrupt" (Angus MacInnis, 12 February 1953), Chiang as "a nobody [whose] rump regime on Formosa means nothing. We should disown him." (H.W. Herridge, 16 March 1959); and Nationalist China as a "puppet to the U.S ... a dictatorial, semi-fascist type of government." (David Lewis, 5 August 1971, *Ottawa Journal*).
16. Pearson in the House of Commons, 5 February 1953 and 1 April 1952; Pearson press conference in Washington, 22 January 1964, as quoted in Charlotte S.M. Girard, *Canada in World Affairs*, Vol. XIII, 1963- 1965 (Toronto: Canadian Institute of International Affairs, n.d.).
17. Standing Committee on External Affairs, 22 May 1951; House of Commons, 1 April 1952.
18. The material in this section is principally drawn from the essay by B. Michael Frolic, "The Trudeau Initiative", in Evans and Frolic, eds., *Reluctant Adversaries*, *op. cit.*.
19. See Bernard T.K. Joei, "ROC-Canada Relations", in Joei, ed., *From Pacific Region Toward Pacific Community* (Taipei: Tamkang University Press, 1989), pp. 153-168; Joseph Tsu-tien Wu, "A Look at the Past and the Future of Canadian-R.O.C. Relations", *International Conservative Insight*, Vol. 4, No. 2 (30 April 1989), pp. 15-18; Simma Holt, "Our Eighteen Year Error", *ibid.*, pp. 9 and 20; *idem*, "Canada: A Growing Child in the Family of Nations Developing Awareness: Gim Sun Is in Pacific Asia—Taiwan", in Bernard T.K. Joei, ed., *Canada in the Evolving Pacific Community* (Taipei: Tamkang University, 1987), pp. 157-70; and Eric Downton, *Pacific Challenge: Canada's Future in the New Asia* (Toronto: Stoddart Co., 1986), especially Ch. 18, "Trudeau Vs. Taiwan"; and James Rusk, *The Globe and Mail*, 3 April 1989, C2.
20. As quoted in Arthur Andrew, "'A Reasonable Period of Time': Canada's De-Recognition of Nationalist China", in Evans and Frolic, eds., *Reluctant Adversaries*, *op. cit.*.

21. Peter C. Dobell, *Canada in World Affairs: 1971-1973* (Toronto: CIIA, 1976), p. 185; *Free China Journal* (Taipei), 12 January 1989; interviews at DEA, June 1989.
22. On the reaction in Taipei to the change of recognition, see F.Q. Quo and Akira Ichikawa, "Sino-Canadian Relations: A New Chapter", *Asian Survey* (May 1972), p. 397.
23. To some the relationship with China seemed to offer infinite possibilities. In the honeymoon years just after recognition, two commentators made the interesting claim that even if Taiwan retaliated in commercial ways, "The significance of Taiwan trade for Canada ... cannot withstand the slightest protest from Peking. Whatever Canada may lose in Taiwan, she can gain ten-fold in the new China market". F.Q. Quo and Akira Ichikawa, "Sino-Canadian Relations: A New Chapter", *Asian Survey* (May 1972), p. 397. It should be added that trade officials tended to be more reserved about the economic gains to be had. On the eve of the recognition of the PRC, the Department of Finance and the Ministry of Trade and Commerce both reported that it was possible that, from an economic point of view alone, recognition might be costly. Their concerns were not the Taiwan trade, which was still quite small, but possible American retaliation.
24. See Janet Lum, "Recognition and the Toronto Chinese Community", in Evans and Frolic, eds., *Reluctant Adversaries*, *op. cit.*.
25. One issue that was not a problem was the extension to Taiwan of most-favoured-nation status. In a curious twist to the long-standing Canadian position, it was automatic because Taiwan was considered to be part of China. Ambiguity had its occasional advantages.
26. William Saywell observed to the Special Joint Commitee on Canada's International Relations in 1985 that "We have been at the extreme end of the cautious spectrum on having informal relationships with Taiwan". The Committee seemed to be of a similar view for in its final report it advised the government to "encourage the Canadian private sector to establish an office in Taiwan to assist Canadian companies to develop business relations there" in such a way that it "will not affect Canada's important relationship with the People's Republic of China". See *Interdependence and Internationalism: Report of the Special Joint Committee on Canada's International Relations* (Ottawa: Government Publishing Centre, June 1986), pp. 80 and 148.
27. *Globe and Mail*, 22 May 1990.
28. On the CANDU issue, see *International Perspectives*, April-May 1983, pp. 11-12 and November-December 1983, pp. 4-5; *Hansard*, 28 April 1983, 4 May 1983, 10 May 1983, and 21 September 1983; 29 November 1983, Standing Committee on External Affairs and National Defence. See also *International Canada*, February-March 1986, pp. 7-8; *The Globe and Mail*, 12, 13, 17 and 26 February, 3 March 1986 and 18 December 1989.

29. The best one-volume treatment of Taiwan's economic and political development is Thomas B. Gold, *State and Society in the Taiwan Miracle* (Armonk, N.Y.: M.E. Sharpe, 1986).
30. On Taiwan in the context of Northeast Asia, see Mitchell Bernard, *Northeast Asia: The Political Economy of a Postwar Regional System* (Toronto: Joint Centre for Asia Pacific Studies, Asia Paper Number 2, 1989). On Taiwan and Southeast Asia, see David C.L. Auw, "ROC-ASEAN Relations in the Changing Asia Pacific Strategic Balance", presented at a conference on "The Changing Context of Security Relations in Southeast Asia", Chateau Montebello, 1-4 May 1990.
31. Some of these concerns were identified earlier in the decade by Roy Matthews in his useful monograph, *Canada and the "Little Dragons": An Analysis of Economic Developments in Hong Kong, Taiwan and South Korea and the Challenge/ Opportunity They Present for Canadian Interests in the 1980s* (Montreal: Institute for Research on Public Policy, 1983). A more recent study also points to some worrisome trends. See Someshwar Rao and Farah Tcharkari, *Asia Pacific Rim Countries: Trading Opportunities and Challenges to Canada* (Ottawa: Economic Council of Canada, 1990).
32. The two best studies of recent political change in Taiwan are Cheng Tun-jen, "Democratizing the Quasi-Leninist Regime in Taiwan", *World Politics*, Vol. XLI, No. 4 (July 1989), pp. 471-99; and Tien Hung-mao, *The Great Transition: Political and Social Change in the Republic of China* (Stanford: Hoover Institute, 1989).
33. See the suggestive *Round Table Conference on Chinese and American Cultural and Educational Relations, 1947-1987* (Washington: Coordinating Council for North American Affairs, 1988), especially Tsai Wen-hui, "The U.S. Educated Political Elite and Its Impacts [sic] on the Modernization of the R.O.C. on Taiwan". Republic of China (Stanford: Hoover Institute, 1989).
34. See Philip C. Chang, ed., *Proceedings of Canada-Taiwan Higher Education Conference: Setting the Agenda for Future Cooperation* (Calgary: The International Centre of the University of Calgary, in cooperation with the Asia Pacific Foundation of Canada, May 1991).

B. MICHAEL FROLIC*

Canada and the People's Republic of China: Twenty Years of a Bilateral Relationship 1970-1990†

THE ESTABLISHMENT OF DIPLOMATIC RELATIONS, 1970

In 1970 Canada established diplomatic relations with the People's Republic of China, the first Western nation to do so since France in 1964. Over twenty years had gone by since Chester Ronning sat in Nanking waiting in vain for Ottawa to recognize the new Communist government. The Korean War froze that initial attempt. During the nineteen-fifties and sixties at least four further Canadian efforts at establishing relations had failed. This has been attributed to American opposition to the legitimization of relations with the People's Republic, but it is also fair to say that there was considerable Canadian reluctance to recognize the PRC. Many Canadians, especially in Quebec, did not want to "reward" Chinese Communist aggression by proffering recognition. The rapid growth of Canada's wheat sales to the PRC occurred in the sixties without benefit of formal diplomatic relations. Why jeopardize this profitable trade? Prime Minister Lester B. Pearson had been repeatedly embarrassed in his efforts to gain admission for the PRC in the United Nations. Faced with China's adamant refusal to accept either a "two Chinas" or a "one China, one Taiwan" policy, many Canadians, among them John Diefenbaker, Leader of the Opposition, did not want to abandon Taiwan as the price for establishing relations with the People's Republic.[1]

By the late nineteen-sixties, however, the situation had changed. In the midst of the Cultural Revolution, and locked in a bitter dispute with her former close ally, the Soviet Union, China was signalling a willingness to rethink her relationship with the non-Communist world. American hostility to China was

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† Presented at the symposium, "Canada and the Growing Presence of Asia", University of Victoria, 4 June 1990.

diminishing. By the end of 1969 President Richard Nixon and Henry Kissinger had begun their secret diplomatic efforts to normalize relations with the PRC. Canadian fears of American economic retaliation if Canada were to recognize the PRC had subsided. According to public opinion polls, for the first time a majority of Canadians favoured recognition. In 1968 the voters had chosen a prime minister, Pierre Trudeau, who was bound by both Liberal Party platform and strong personal conviction to seek the establishment of diplomatic relations with the People's Republic of China as soon as possible.[2]

The ensuing negotiations, which began in Stockholm in February 1969, took twenty months to complete. While both sides agreed upon the desirability of establishing formal diplomatic ties, Taiwan remained the principal stumbling block. The Chinese government wanted Canada to acknowledge that Taiwan was "an inalienable part" of the People's Republic of China. The Canadian side was unwilling to acknowledge Chinese sovereignty over Taiwan. The negotiations remained deadlocked over this issue until a compromise formula was found, wherein "the Canadian Government takes note of this position of the Chinese Government". Mitchell Sharp, Secretary of State for External Affairs observed that in "taking note" of the Chinese standpoint, Canada "neither endorsed nor challenged" this position. With this fomula the two countries were able to agree to establish formal diplomatic relations on 13 October 1970.[3] As a consequence of this agreement, Canada severed all diplomatic links with Taiwan. Even though Canada did not acknowledge the PRC's claim to sovereignty over Taiwan, Canada could not maintain a diplomatic relationship with both governments. Canada had never had a diplomatic mission in Taiwan. Unlike the Americans, after the Communist victory in 1949 Canada had not followed the defeated Nationalist Government to Taiwan. On the other hand, the Nationalists had continued to maintain an Embassy and Consulate in Canada. These were now closed down, the Ambassador was given a farewell lunch by Mr. Sharp, and official ties between Canada and the fourteen million inhabitants of Taiwan had come to an end.[4]

At the United Nations on 14 October Mr. Sharp noted, "I don't think there has been any other action taken this year as important as Canada's agreement to establish relations with Peking, and I can think of no initiative that is more likely to advance (Peking's admittance to) the United Nations than what we did yesterday". The Canadian media were enthusiastic over this foreign policy coup, and, significantly, editorials in nineteen of twenty-five major American newspapers supported the Canadian action praising Canada for her "pragmatic" and "logical" foreign policy. For most Canadians the Stockholm Agreement was a foreign policy achievement rivalling the internationally acclaimed successes of Lester Pearson in the nineteen fifties when Canadian diplomacy reached its zenith. Of over forty Canadian diplomats and government officials whom this writer interviewed, every last one believed the normalization of relations with the People's Republic was Canada's most notable foreign policy achievement. In the words of one senior diplomat:

> We took the lead in the international arena against considerable odds. There was no guarantee that the Chinese would even show up, and the

> Americans were hardly supportive...the Agreement is a credit to the good judgement and professionalism of those Canadians engaged in the foreign policy process.[5]

The establishment of diplomatic relations with China was one of those dramatic events which serve as markers in history from a variety of perspectives. First, the successful completion of the Stockholm negotiations reinforced the goals and assumptions of Pierre Trudeau's new Canadian foreign policy. It showed that Canada could break from American influence and embark on a path that diverged from officially held American positions. At a time when anti-Americanism was gaining strength in Canada, the recognition of the PRC could be viewed as an act of emancipation from unnecessary American tutelage, a vindication of the "third option" in Canadian foreign policy. Second, it represented the fulfilment of Trudeau's vision for China. As a young man of thirty Trudeau had visited China in 1949, a trip which committed him in the 1950s to supporting the recognition of China. This was reinforced by his second visit to Chian in 1960. Trudeau and Hebert wrote that, "the two-China policy is based on ignorance of the Chinese mentality".[6] It was in Canada's interest to develop closer ties with China, although, "Time is on its side and China is in no hurry". In recent conversations Trudeau has indicated that he was especially proud of his role in the establishment of diplomatic relations with China.[7]

Third, it was in everybody's interest to bring China out of isolation and into the international world community. Even if the PRC was a pariah state it would be more amenable to Western influence within the conventional state system. Recognition by Canada was an important step in this direction. It could make China a more responsible world citizen, could bring about the softening of China's militant communist posture and, not incidentally, might accelerate the detachment of China from the Soviet orbit. At the level of "high politics" the de-isolation of China and her possible detachment from the Soviet Union were important positive elements in Canada's decision to recognize the PRC. The "Canadian formula" for the recognition of the PRC opened the door to a series of similar agreements between China and a dozen other Western nations in the early seventies. Within a year the PRC had gained admission to the United Nations.

Fourth, Canada also had a strong "low politics" goal, the enhancement of trade with the PRC. For many Canadians this had been the main rationale for establishing diplomatic relations. Priority access to a market of 700,000,000 would bring expanded trade opportunites and China was known to reward her friends. Canadian traders and officials were looking to build upon the sixties and diversify into manufactured and other value-added goods. The Chinese had a strong credit rating and paid their bills promptly. It was not suprising that the first major Canadian delegation to China following recognition was led by the Minister of Industry, Trade and Commerce in June of 1971.[8]

Fifth, by 1968 the decison to recognize the PRC had substantial public support in Canada. Even the sacrifice of Taiwan could be seen as the price that

had to be paid for "doing the right thing". The policy had the backing of all the major political parties, and Robert Stanfield, Leader of the Opposition, was one of the first official Canadian visitors to China following the establishment of diplomatic relations. The Canadian Chinese community which was surmised to be strongly pro-Nationalist suprisingly offered little opposition to the new situation. Concerns that the local Chinese communities might become a battle-ground between pro-Communist and pro-Nationalist forces never materialized. In the wake of recognition one could find a reservoir of good will and a flood of excitement and euphoria towards China.[9]

Sixth, the successful conclusion of the Stockholm negotiations bolstered the faltering reputation of Canada's foreign policy professionals in the Department of External Affairs. They had been put under seige by the new Government of Pierre Trudeau and advisors such as Ivan Head and Michael Pitfield. Trudeau initially was no friend of the Department and sought to circumscribe its influence and working style. In 1969 Trudeau observed on national television, "I think the whole concept of diplomacy today is a little bit outmoded...I believe it all goes back to the early days of the telegraph when you needed a dispatch to know what was happening in country A, whereas now most of the time you can read it in a good newspaper".[10] The heyday of Pearsonian diplomacy had passed. Canada's importance in the international arena had diminished. The bright young men who had taken over foreign policy making and its implementation after World War II were now aging. The instruments of foreign policy decision making and the organization of multilateral and bilateral relations were becoming increasingly complex and difficult to manage. The recognition of China, however, showed that traditional diplomacy still had its place; that the foreign policy professionals could be counted on to carry out Government policy even in a difficult situation; that it was possible to adapt to new conditions. In marking the departure from Pearsonianism to the new foreign policy of Trudeau, the China recognition decision reaffirmed the importance of the Department of External Affairs, and made clear that in the management of the new Canadian-Chinese bilateral relationship, the Department would continue to be the key player.[11]

In 1987 the Ministry of Foreign Affairs agreed to provide an official Chinese perspective on the recognition decision in a series of interviews with this writer in Beijing.[12] Yao Guang, who was Ambassador to Canada in 1972-1973, and, more important, had been in charge of the negotiations in Beijing from 1968-1970, notes:

> Our view was that the Canadian Government and the Canadian people always had the desire to establish relations with the PRC. The demand for recognition in Canada was always greater than opposition to it.

From the Chinese perspective the catalyst was Pierre Trudeau. "Trudeau was brave. We do not know why Trudeau was able to do this and not Pearson. Maybe if Pearson had been Prime Minister in 1968, maybe he, too, would have been able to act." According to Yao, there were two basic issues which had to be solved. One was the question of American influence: "We understood the

situation well. Canada has such a big neighbour. Canada just could not act. We were able to wait patiently until Canada found herself in the position where she could take action." Yao went on to say that in 1968 American opinion towards China was changing but, "it was not sufficient for the US Government to support the Canadian decision to recognize China. However, it was enough to persuade the Americans not to interfere." The second issue was Taiwan, and to a large extent this issue intersected with the American factor. "American pressure was mostly on the issue of Taiwan". The Chinese side knew it could convince Canada not to follow a "two China", or a "one China, one Taiwan" policy. "Taiwan is an inalienable part of Chinese territory. Once this was explained clearly then you were better able to understand our position." Yao observed that the resolution of the Taiwan issue occurred "step by step" in the negotiations. The Chinese respected the Canadian attempt to avoid the issue but, "we are patient. We were prepared to wait for 100 years or 200 years until the Canadian side was ready. That was our policy."

China was satisfied with the Stockholm Agreement. While Canada did not concede Chinese sovereignty over Taiwan it did, nontheless, terminate diplomatic relations with the Taiwan Government, reaffirming Beijing's "one-China" policy. This represented an important coup internationally. On the bilateral level, Yu Zhan, former Ambassador to Canada, 1983-1986, observed, "The relationship developed quickly and steadily after 1970. We are satisfied with what was achieved." Yao admitted that the negociations took a long time (20 months) but, "there was no conflict of interest between us. We never considered Canada as a negociating opponent but as someone with whom we could develop understanding." Indeed, Yao pointed out that, "We wanted to help our Canadian friends and make it easier for them". The latter view, however, was at the time not shared by the weary corps of Canadian negotiators and policy-makers who had spent the better part of two years of their careers focused on the recognition decision. Thankful that it was over they saw the Chinese negotiators more as skilled adversaries rather than kindly helpmates.[13]

THE BILATERAL RELATIONSHIP, 1970-1990

The Canadian Embassy in Beijing began operations in January 1971, and the Chinese Mission opened in Ottawa a month later. Canada's first Ambassador was Ralph Collins, Assistant Undersecretary of State for External Affairs. Collins, who had been closely involved in the Stockholm discussions. The Chinese, still in the midst of the Cultural Revolution, kept the small band of Canadians at a distance. Personal interaction with ordinary Chinese was almost impossible, and the Canadian side made sure that Embassy officials and staff could travel frequently to Hong Kong to recover from the loneliness and isolation of life in Beijing. Despite these adverse conditions, however, Canadian diplomacy in China prospered. Canadians clamoured to go there, as tourists, students, teachers and traders. The Department had so many requests for working visits from Canadian politicians and officials that it set up a special

committee to deal with these requests. In June 1971, the first major working delegation to the PCR was headed by Jean Luc Pepin, the Minister of Industry, Trade and Commerce. This group of business and government representatives met with Chinese Premier Zhou Enlai. The Chinese side agreed that China would consider Canada first as a source of wheat as the need arose. Each side announced that it planned to hold major trade exhibitions in the other's country in 1972, and that they had agreed to have annual bilateral trade consultations, beginning in 1971.[14]

In August 1972, the Secretary of State for External Affairs, Mitchell Sharp, opened the Canadian Trade Fair in Beijing. With over 500 representatives from 200 Canadian companies, the Fair was the largest Canadian trade exposition ever held outside Canada. It occupied four large halls and two exterior exhibition areas, with 200,000 square feet of space. 250,000 Chinese attended during the fair's twelve days. In Canada, the Chinese Foreign Trade Minister opened the Chinese Trade Fair at the Canadian National Exhibition, held trade talks, and visited the birthplace of Norman Bethune, the Canadian doctor and Communist, who had been turned into a Chinese hero by Chairman Mao during the Cultural Revolution. In the next few months the two sides signed an air transport agreement, settled the last of the Canadian Government's outstanding claims against the Chinese Government, and agreed to an exchange of students.

The visit of Prime Minister Trudeau in 1973 was the first key event in the development of the Canadian-Chinese relationship. For both sides the Trudeau visit marked the real institutionalization of the bilateral relationship. In meetings with his counterpart, Zhou Enlai, the Canadian Prime Minister signed agreements and understandings in the areas of trade, medicine, culture, sport, education, science and technology. The two sides agreed on a consular package, "which will remove many of the most important obstacles to the movement of peoples between the two countries". Agreement was also reached on a program to reunite families, in this case, permitting the emigration of Chinese to join members in Canada. This was the first such agreement made by China and the decision, which was personally attributed to Zhou, delighted the Canadians.[15]

Specific objectives of the Trudeau visit focused primarily on economic and commercial relations between the two countries. The Canadian government wished: (1) to obtain a written agreement to govern the conduct of Chinese-Canadian trade; (2) to secure a renewed Chinese undertaking to look to Canada first as a source of wheat; (3) to gain a commitment that China would look to Canada first as a source of plant technology and sophisticated equipment in the areas of power generation, petrochemicals, mining, and oil exploration and development; (4) to secure long-term arrangements for the supply of potash; (5) to win Chinese agreement to look to Canada first for raw and processed industrial materials; (6) to improve access by Canadian exporters to China and to open up their means of communication with responsible Chinese authorities; (7) to gain quick action on Canadian proposals for exchanges of commercial and economic missions.

The meeting between Trudeau and Zhou was an event of special significance. The two leaders took an instant liking to one another. Participants on both sides recall the warmth and respect that characterized their meeting. Trudeau observed that, "Thirteen years ago I sat in this Great Hall, thinking some day we should recognize this nation. I saw at a distance and with admiration the leaders of China...and for me it is a great pleasure now to be together with some of these leaders." Zhou said that China owed Canada a large debt of gratitude:

> Canada was the first country...that granted recognition in 1970. It pushed a series of Western European countries into taking a similar step. Your support of China in the voting at the United Nations in 1971 also brought similar results.

In this spirit Zhou turned to Sino-Canadian trade. He said that as a rule he never signed bilateral trade agreements but because Trudeau and the Canadians requested such an agreement he would sign. He noted that his aides complained about China's large trade deficit with Canada and insisted that Canada do something about it. Zhou observed that the deficit might be China's fault: "Maybe the problem is not just Canadian textile restraints but also the poor dye in Chinese shirts." He wondered why Taiwan was so successful in the Canadian market, and concluded, "If the quantities, varieties and packaging did meet your needs, and if prices were lower than those of Taiwan, and you still bought from Taiwan, then we would have good reason to complain to the Canadian authorities."

When Trudeau returned home he reported to the House: "We left Canada with high expectations. I am able to say, Mr. Speaker, that the willingness of the Chinese government to accept our point of view and to engage with us in activities of benefit for the people of Canada, more than met those expectations." The government notes, "Almost all the objectives of the visit were achieved...the personal warmth of the leaders offers a basis for concluding that the Chinese want the relationship to remain at a high level for some time to come." The Chinese viewed Canada not just as a source of agricultural staples and specialized technology, but also as a "testing ground for Chinese experiments in the field of normalizing their international conduct". So Canada still could lay claim to occupying a particular place in China's world, although, "it might be unwise to think of it as a special relationship". Still, the results of Trudeau's visit appeared to have solidified, at least in the forseeable future, Canada's advantageous position in China. Access to China's top leaders had been reconfirmed, and significant issues of substance resolved. With a signed trade agreement, a large wheat sale, and China's declared interest in a wide range of Canadian resource products and manufactured goods, it appeared that Canada had more than met its trade objectives. Based on the results of the Trudeau visit, the Canadian side concluded that prospects were bright for a major breakthrough in Canada-China trade.

But this expansion of trade did not materialize at the level envisaged by Canada in 1973. First, China was still in the midst of domestic political turmoil

and could not commit itself to full scale involvement with the outside world. Zhou, architect of China's re-emergence from the Cultural Revolution, was already gravely ill. For the next few years, as both Zhou and Mao passed from the scene amidst internal leadership conflict, it was difficult for China to make large-scale international commitments. Second, Canada now was only one of many suitors assiduously courting the PRC. While the Chinese initially had rewarded "old" friends such as Canada with enhanced trade opportunities and cultural exchanges, "new friends" such as the United States, Mexico and Australia now claimed these rewards. There was no way that China could satisfy the expectations of all her suitors. Third, in a situation of increased competition, Canadian traders were losing ground. Many apparently were unwilling to "pay their dues", that is, to put in the time and the investment necessary to cultivate the China market. Euphoria increasingly gave way to disappointment. By the late seventies the excitement generated in Canada by Trudeau's visit had been dimmed by the belated realization that the China trade required a great deal of hard work and more realistic expectations as to what could be achieved.

The second benchmark was Canada's decision to exclude Taiwan from the 1976 Montreal Olympics. Unofficial relations with Taiwan had continued after recognition of the PRC. By 1976 two-way trade with Taiwan reached CDN $330 million, compared with CDN $500 million with China. Taiwanese citizens contiued to visit Canada but could not refer to Taiwan as the "Republic of China" and were forbiden to fly the ROC flag. Despite the Government's attempts to discourage official contacts, several problems soon emerged. The Taiwanese press correspondent refused to go home, staying in Canada as a private citizen. He remained a member of the National Press Gallery. This infuriated the PRC which then refused to permit its NCNA correspondents to join the Gallery. Huang Hua, the Chinese Foreign Minister, complained that, "Nationalist activities have reached staggering proportions and are detrimental to Canadian-Chinese relations". The Canadian Government replied that, "private opinions or declarations should not be construed as reflecting official policy". The PRC was vigilant in pointing our alleged breaches in Canadian official policy regarding Taiwan. The Chinese Embassy protested when Canadian members of Parliament travelled to Taiwan as unofficial visitors; when the Taiwan trade office in Canada used the forbidden phrase, "Republic of China"; when, during a tour of Canada, a Taiwanese performing troupe tried to fly the Republic of China flag and play the ROC national anthem.[16]

The most dramatic event was Canada's decision to bar Taiwanese athletes from the 1976 Olympics. Canada acted in the face of stiff opposition from the International Olympic Committee and the United States. The PRC had withdrawn from the IOC in the nineteen fifties for political reasons. In the intervening years Taiwan participated in the Olympics as the representative of China. In 1975 the PRC formally applied for readmittance to the IOC as a prelude for inclusion in the 1976 Olympics. The PRC met the formal IOC requirements for admission as the representative of China and insisted that Taiwan first had to be expelled. There could be no "two-Chinas" policy in

international sport. The IOC stalled. A majority of its members favoured dual membership. The problem was exacerbated by the fact that Lord Killanin, IOC president, kept postponing a trip to Beijing, where it was hoped he could personally resolve the crisis. This did not happen. Taiwan remained a member of the IOC and the PRC continued to be excluded.

The Canadian Government had said repeatedly that athletes of a country purporting to represent another country with whom Canada had diplomatic relations could not participate in any Olympic or international activities on Canadian soil. Taiwanese athletes could compete in Montreal, but only as representatives of Taiwan, not China. They could not fly the ROC flag or use the ROC national anthem. Canada noted that in 1960 Taiwan had competed in the Rome Olympics as Taiwan and not as the Republic of China. The ROC replied that this was done under protest and they had flown the ROC flag and used the ROC anthem. On 9 July 1976, a few days before the start of the Games, Canada refused entry to several Taiwanese athletes. The IOC was stunned. It tried, finally, to persuade Taiwan to compete under the Olympic flag. The Taiwanese first hesitated and then, on the day before the opening of the Games, refused to participate. The United States was furious with the Canadians, and initially considered withdrawing from the Olympics. The Americans were so critical of the Canadian action that the Secretary of State for External Affairs accused President Ford of "external interference in Canada's affairs".

Given the complexities of the issue, the intrusion of politics into the Olympics, and the powerful forces arrayed against the Canadian position, it is not surprising that a vigorous debate developed in Parliament. Otto Jelinek, a Conservative M.P., wondered why Canada had "waited until the eleventh hour, harming not only Montreal, but the whole Olympic idea? Why the sudden flip-flop?" The Prime Minister replied, "There was no sudden flip-flop. This problem has been in discussion with the IOC for more than a year. They apparently have not seen fit in one way or another to solve this problem as of yet." John Diefenbaker said that both the *New York Times* and the *Washington Post* had condemned the Canadian action. The Prime Minister replied that he was disturbed that, "as a matter of course, so many Canadians follow the example of the Right Honourable gentleman and assume the Government is wrong. The Government is right on this particular issue."

The Olympic decision was unpopular but was consistent with Canadian policy regarding Taiwan. It was the logical extension of Canada's position on Taiwan at the conclusion of the Stockholm talks in 1970. Prime Minister Trudeau had qualms about excluding Taiwan if it persisted in representing itself as "China" on Canadian soil, regardless of the situation. He refused to be pressured by either the United States or the IOC. The latter, through its stonewalling, had precipitated a crisis for which Canada had to bear the burden of public criticism. The PRC was grateful for Canada's support on this issue, although it is difficult to conclude that Canadian-Chinese relations noticeably improved as a result of the action. One Canadian official recalls: "I dreaded having to meet with the Chinese in 1975 and 1976. All they talked about was

getting into the sports federations and then the Olympics. They kept telling us that our position was wrong, or we were not doing enough. When the Canadian position finally prevailed there wasn't much Chinese thanks for what we did." The Olympics decision was an unsettling experience in which rigorous application of the "one-China" policy won Canada few friends, and when many Canadians for the first time became uncomfortable with the political implications of the Canadian-Chinese bilateral relationship.

In 1981 Cabinet approved a Canadian aid program for the PRC. This decision to extend development assistance to the PRC is the third benchmark in the bilateral relationship. When the two countries established diplomatic relations in 1970, development assistance was not on the agenda. The Canadian International Development Agency (CIDA) had only recently been set up, and few, if any, Canadians advocated granting aid to China, a Communist nation. Trade was one thing, but aid was quite another. Even if Canada had offered development assistance it would have been spurned by the Chinese who at that time wanted no favours of this type from the ouside world. Throughout the nineteen seventies, however, Canada and the PRC exchanged a large number of science and technology missions. The Chinese regarded these missions as an opportunity to learn about Western advanced technology. The potential benefits of technology transfer and the training of Chinese in advanced Western techniques became attractive to a Chinese leadership which, in the latter nineteen-seventies, was embarking on the road to modernization. A former Canadian ambassador to Beijing observes:

> The science and technology exchanges were a type of development assistance. We gave the Chinese far more than they gave to us. Once Ottawa accepted this, then we could gain substantial long-term benefits. Whenever the Chinese complained about the large Canadian trade surplus, I always hastened to remind them they were getting other benefits from us, such as the cheap transfer of high technology and the training of Chinese in advanced Western techniques.[17]

By the end of the seventies Canada was inclined to give, and the Chinese to take, developmental assistance funds. In 1978 China joined the International Monetary Fund (IMF) and the World Bank, and had asked the United Nations Development Programme (UNDP) for help in the field of technical training. This was the first time in 20 years that the Chinese had accepted aid from anyone.[18] In 1979 the Chinese accepted $19 million of indirect aid from the United Nations High Commission for Refugees for resettlement of refugees who had entered China from Vietnam. Contact was also established with WHO, UNESCO, and FAO to discuss the launching of programs in China. In 1979 the Canadian International Development Research Council (IDRC) concluded an agreement with the PRC to establish China's first bilateral development assistance program with a Western country since the Communist victory in 1949.[19] This model program, along with Canadian emergency food relief grants in 1981, paved the way for the substantial Canadian commitment to provide bilateral development assistance to China.

The Canadian decision to grant a large amount of development assistance raised many questions in Canada. Concern was expressed that a new China aid program would be like a bottomless pit. The PRC was so big and needed so much help that it would simply exhaust the CIDA budget. It would take away resources needed for existing programs with other countries. Some officials and politicians wondered whether Canada should be providing aid to a Communist country, specifically a country which might use that aid to strengthen its nuclear and military capabilities. Should Canada provide assistance to an authoritarian regime that significantly restricted human rights? Was China, a ranking regional power and potential superpower, that "poor"? Should not Canada wait until Deng Xiaoping's reforms had taken root, when China would have a more effective infrastructure that could better maximize Canadian aid? Michel Gauvin, the Canada's Ambassador in Beijing, argued that the time was not ripe to give aid to China. "Why was Canada suddenly in such a hurry when the chaos of the Cultural Revolution was only five years past?" He said that China did not satisfy the usual criteria for prospective aid recipients. In his opinion, China "was comparatively literate, with a group of well-trained cadres; not a new country being born, but an old civilization coming to life".[20]

Gauvin's opinion, in the end, represented a minority viewpoint. Mark MacGuigan, then Secretary of State for External Affairs and the Minister responsible for CIDA, recalls, "There was no great opposition to it in Cabinet. There also wasn't much opposition to it in my Department." He saw the CIDA-China initiative as "a way of continuing the process of drawing the PRC into the world community".[21] Cabinet approved the decision in the summer of 1981, opening up a new dimension in Canadian-Chinese relations. The program evolved quickly into one of the most important instruments in the bilateral relationship. The emphasis was on technology transfer and human resource development, focusing on targeted sectors such as agriculture, forestry, management and energy. Initially the program disbursed approximately CDN $20 million annually. Later the amount of bilateral assistance was doubled. Today China annually receives over CDN $100 million in Canadian aid, bilaterally, and through Canadian contributions to multilateral international organizations.[22] The CIDA program has trained thousands of Chinese managers, officials and technicians. It has developed projects which join the aid and trade objectives of both sides. In Canada it has helped univerities, colleges and other non-governmental organizations to develop links and expertise with their Chinese counterparts. In less than a decade Canadian development assistance has become one of the most valued instruments in the Canadian-Chinese bilateral relationship.

Prime Minister Brian Mulroney's visit to China in 1986 was the fourth major event. When the Conservatives came to power in 1985, China policy was not an issue. There had been no public debate over policy alternatives, except for vague promises by the Conservatives to improve Canada's trade with China. While Mulroney's priorities lay in domestic policies and in Canadian-American affairs, improved economic ties with the Asia-Pacific

region were also an important part of the new Government's agenda. Canada's trade with Korea and Japan had grown rapidly, although most of this increase was in imports from, rather than exports to, these nations. Trade with the PRC had been growing. Canada maintained a solid surplus of CDN $38.6 million, primarily due to large wheat sales which comprised two-thirds of Canadian exports to the PRC.[23] With China continuing to open her doors to Western technology and trade, prospects for an expanded Canadian share of the China market seemed to be improving. In January 1984 the Chinese Premier, Zhao Ziyang, visited Canada and became the first Communist leader ever to address Parliament. His trip set off a round of top level visits which culminated in Li Xiannian, President of the PRC, travelling to Canada in 1985, and in Prime Minister Mulroney making his visit to Beijing a year later.

During Li's visit in 1985, the Canadians sought, "to emphasize our commonality of interest on international questions and the complementarity of our economies in terms of bilateral realtions". While the two leaders also discussed such issues as disarmament, the Soviet occupation of Afghanistan and north-south relations, the main item on both their agendas was economic relations. The Chinese wanted accelerated transfer of Western technology and access to concessional financing. They sought increased Canadian investment in joint ventures to compensate in part for the chronic trade imbalance which stood at 4:1 in Canada's favour. Li expressed Chinese concern over Canadian textile restraints and antidumping laws. Ottawa promised to find ways to expand Chinese exports to Canada; to promote technology transfers to the PRC; to improve Canadian export financing arrangements. From Ottawa's perspective, a top priority was to raise the proportion of manufactured goods in Canada's total exports to the PRC, and to accomplish this goal by means of large scale projects in agriculture, energy, forestry, transportation, and communications. As examples the Government cited recent sales of earth satellite stations by Spar Aerospace, and to successful bidding by PetroCanada and Ranger Oil for drilling contracts in the South China Sea.

In the ten months following Li's visit, the Canadian side worked to develop policies and programs that would enable Mulroney to follow up these initiatives during his 1986 visit. The Canadian Prime Minister met with all the top Chinese leaders at the time (Deng Xiaoping, Li Xiannian, Zhao Ziyang and Hu Yaobang). Mulroney announced that Canada would set aside CDN $350 million for concessional financing, i.e. provide funds for export development at low interest rates. These funds were to be blended with a largely unused CDN $2 billion line of credit which Canada had granted earlier at conventional rates. Now, with blended concessional financing, Canadian companies would be better positioned to compete with other exporting nations in the China market.[24] Mulroney also announced that Ottawa was doubling CIDA's bilateral aid commitments over the next five years, from CDN $100 to CDN $200 million. This would provide more of the technology and the training that China was seeking. More emphasis was also to be placed on a closer linkage between development assistance programs and trade objectives. Canadian companies could now draw on CIDA funding in the early stages of

massive projects such as the Three Gorges hydroelectic power project on the Yangtze River. This decision drew the Canadian Government into closer cooperation with the private sector. In the words of one Canadian trade official, "To be competititve we have to use all our resources, such as cheap credit, more government intervention and the pooling of skills and energy through the formation of sector specific consortia. That is how we will win the big power dam contracts of the eighties and nineties."[25]

After the Mulroney visit, trade with the PRC improved markedly, especially in manufactured goods, which rose to an all-time high of CDN $500 million. Some deals, after being under discussion for years, had finally been completed. The Chinese were in a buying mood and the Canadian side was more aware of, and focused upon, China's priorities. Canadian businessmen were finally learning how to sell their products in the Chinese market. The federal government had restructured its China trade promotion activities with the merger in the early 1980s of the Departments of Industry, Trade and Finance and External Affairs into a larger, more trade-oriented Department of External Affairs (DEA). Additonal officers were hired to focus on the China trade. To coordinate the expanding work of government in these areas, the federal government established an intra-departmental working group of representatives from DEA, the Export Development Corporation (EDC), CIDA, the Department of Finance and other key departments.[26] In 1987 two-way trade exceeded CDN $2 billion for the first time, and prospects for 1988 looked still better. The Government, following upon the momentum of the Mulroney visit, decided that the time was ripe to launch a major review of Cananda's relationship with the PRC, to create "Canadian Strategy for China" that would build upon the new policies and programs of the Mulroney administration. This "Canadian Strategy" took several months to complete and involved sixteen federal departments and other agencies, as well as consultations with provincial officials and the private sector. The review was based upon the premise that, "there is a need for a focussed, orchestrated, and dynamic strategy" to ensure that Canadian programs "could be effective in the increasingly competitive Chinese enviroment".[27]

In the seventeen years since recognition, Canada had established a diverse range of political, social and economic programs with the PRC. Trade had grown steadily, although not at the level that was first anticipated in the early seventies. The new CIDA program and a substantial network of cultural and educational exchanges had given thousands of Chinese and Canadians a chance to live, study and perform in each other's country. The recent flurry of high level visits indicated that the bilateral relationship was viewed favourably by both Governments. Canadian public opinion was positive. Few Canadians doubted the value of this relationship. Like their counterparts in most Western nations, Canadians continued to be fascinated by China. In the words of one official, "We wanted to develop a strategy that could capitalize on Canada's fascination with China, to seize opportunities created by its modernization drive, and to position Canada for the year 2000 when China will be a major world power with a GNP approaching $C1 trillion".[28]

The "China Strategy" was an action plan designed to maximize existing programs, rather than creating new ones. The review targeted sectors; recommended that Canada take advantage of future high level visits to promote economic, political and cultural objectives; advocated closer cooperation between government and the private sector in trade; linked trade and aid goals; focused educational and cultural exchanges; and set up mechanisms to coordinate the work of government bodies involved in the development and administration of China programs, including the convening of periodic meetings of leading business, academic, and other China specialists to ensure that policy would be based on an informed consensus. The document was designed to emphasize trade objectives. The mood in 1987 was that Canada was poised for the big trade breakthrough for which it had been waiting all these years. The instrumentalities were at hand, and the political climate was supportive. The Prime Minister was about to put a personal stamp on a strategy that could carry the bilateral relationship into the 21st century.

1988 was a record year for trade between the two countries. China exported nearly CDN $1 billion to Canada, and Canadian exports to the PRC amounted to CDN $2.6 billion. Canada's trade surplus for the year was CDN $1.6 billion. All were records. Yet only a few months later the two countries experienced the first real crisis in their relationship, the massacre in Tiananmen. This is the fifth benchmark and it has profoundly affected the Canadian-Chinese bilateral relationship. Those responsible for drawing up the "China Strategy" in 1987 had noted that, "The long term durability of China's reform program should not be taken for granted. China could return to more inward looking policies".[29] However, few individuals took that warning very seriously given that in the spring of 1989 Deng Xiaoping's Open Policy had been in existence for over a decade. When 4000 Beijing university students marched to Tiananmen Square on 18 April to commemorate the death of Hu Yaobang, former general secretary of the Communist Party of China, who would have imagined that this "event" would end six weeks later with the slaughter, in front of Western television cameras, of a thousand or more Chinese, by their own army? For a long moment China appeared on the brink of civil war. The Canadian Govenment moved swiftly to evacuate all its nationals from the PRC. The Chinese Government appeared to revert to "totalitarian type" by instituting rigid martial law, suspending the exercise of basic human rights, and seeking to deny the brutality of the "event". Shocked and appalled by what they saw, many people in Canada reacted with outrage, especially when it became clear that the Chinese leadership was refusing to take responsibility for its actions; was blaming "outside agitators" for what had happened; and was seeking to rewrite the historical record in order to justify its actions. The initial reaction of outrage was joined by a realization that the Chinese leadership was riven by conflict and had a shakier grip on power than had previously been imagined. The aging Chinese leaders were incapable of promoting serious political reform, and in such a climate the few fragile blossoms of democracy would have little or no chance to bloom.

On 4 June, Joe Clark, Undersecretary of State for External Affairs made the following statement:

> We can only express horror and outrage at the senseless violence and the tragic loss of life resulting from the indiscriminate and brutal use of force against the students and citizens of Beijing. We are witnessing violence at a scale that can only shock and offend all Canadians. The actions of the Chinese military are inexcusable.[30]

The Chinese Ambassador replied that any sovereign state had the right to take measures to promote internal stability, and that what began as a peaceful demonstration had become "a violent counter-revolutionary riot". The Chinese Government had actually shown extraordinary restraint in what was a domestic affair. Foreigners should not be encouraging elements who oppose the Chinese Government.[31]

During the month of June the Canadian government acted forcefully, propelled by a strong revulsion by many Canadians against the actions of the Chinese Government. The Conservative Government, which had taken a tough stand internationally on violation of human rights, now found itself in the awkward position of jeopardizing Canadian trade gains if it took too hard a line on the Tiananmen massacre. To its credit the Government postponed the signing of five development assistance programs; froze high level visits; and indicated its willingness to extend the stays of Chinese students currently in Canada. Earl Drake, Canadian Ambassador to the PRC, was recalled for consultations. He was the only Western ambassador who returned to his home country following the massacre. On 22 June the Secretary of State for External Affairs assembled over 40 individuals in Ottawa for an airing of views on Canadian China policy. The group included businessmen and traders; representatives from the Canadian Chinese community; academics and professional China watchers; and officials from governmental and quasi-governmental organizations.[32] The large grain dealers pointed out what everyone knew: that in 1989 nearly one out of every three Canadian wheat farmers would get his income from sales to the PRC. The big corporations did not want to risk their investments in the PRC and by and large advocated "business as usual". The Canadian Chinese had been given a mandate from their community to demand severe sanction against Beijing, and to provide assistance for the thousands of students and scholars from the PRC who could find themselves politically stranded in Canada. Most of the academics and representatives from governmental and quasi-govenmental organizations advocated some sort of sanctions, but not at the expense of existing programs and linkages. If only a way could be found to "punish the leaders but continue to maintain links with the people". It could not be "business as usual".

The policy that did emerge on 30 June after a Cabinet decision, conveyed strong Canadian condemnation of the Tiananmen massacre; expressed a commitment to maintain "people to people" relations while avoiding contact with those responsible for the massacre; advocated the continuation of business relations, though "not quite as usual":

> The Government will preserve existing linkages; focus on people to people exchanges; avoid programmes which will benefit the hardliners; defer high level contacts with the Chinese government; withdraw from several large development assistance programmes; hold back implementation of 4 of 5 agreements about to be signed; suspend Canadian participation in the Three Gorges project; review Canada's two billion line of credit for China; suspend government funding for PRC-hosted trade shows; extend student visas for Chinese students in Canada; establish a major programme for assisting PRC students and scholars currently in Canada; evaluate Canadian support of celebratory visits such as symphony orchestras, on a case-by-case basis.[33]

In the year that followed Tiananmen, Canadian cries of outrage diminished. Some projects were not being restored, but the bulk of the bilateral programs remained operative. The two-way flow of traders and educators continued. Middle-level officials on both sides continued to meet one another to implement various programs, but high level meetings were suspended. Lines of credit gradually were restored. Traders continued to make deals and fulfil their commitments. Trade statistics for the first quarter of 1990 showed a 30% increase in Canadian exports to the PRC.[34] On the other hand, it was not "business as usual". The relationship had become constipated. There was awkwardness and a bottling up of emotions. A "special relationship" that once bordered on the euphoric had become routine, if not grim. Over eight thousand Chinese students in Canada applied for landed immigrant status. Canadian willingness to let them stay precipitated an angry reaction from the Chinese Government. Canadian support of human rights in Hong Kong has further exacerbated the bilateral relationship. All in all, these were not the best of times for Canadian-Chinese relations, but even in the midst of crisis the two countries maintained full diplomatic relations and preserved most of their bilateral programs. Tiananmen put a dent in the "China Strategy" of 1987, but as the aging hard-line Chinese leadership departs from the scene and as the memory of Tiananmen fades, the old bilateral relationship so carefully created over twenty years will re-emerge in form and substance, if not fully again in the contest of a "special relationship".

POLICY AND PERFOMANCE: AN ASSESSMENT

The conventional assessment of the 1970 Stockholm negociations is that they were a diplomatic "success story" vindicating Trudeau's vision, restoring Canada diplomatic prominence, and emancipating Canada from the fetters of American tutelage. By and large there is truth in this view, although there is also exaggeration. The Canadian "formula" prevailed, but the cost was high: the abandonment of Taiwan with the later embarrassment of the 1976 Olympics and Canada's refusal to allow Taiwan to participate. Today we are still grappling with the problem of Canada's relationship with Taiwan.[35] The dramatic Canadian diplomatic coup at Stockholm lasted too briefly as an

achievement. Within a year it had been eclipsed by Kissinger's secret diplomacy. Whatever advantages Canada had hoped to obtain by early recognition were lost in the crowd of other Western nations who quickly followed the Canadian example.

Nevertheless, the bilateral relationship which developed in the next twenty years has been both solid and innovative. In the political realm Canada wanted to end China's isolation and bring the PRC into the international community. Post-Tiananmen notwithstanding, this goal was achieved. The China of today, even in its current state of withdrawal, does not resemble the isolated China of 1970. The PRC is an active member of most important international organizations, from the United Nations to the World Bank. A second goal was to detach China from the Soviet orbit, thus weakening the monolithic unity of the Communist bloc. That has happened, although to be sure, Canadian efforts in themselves did not have a direct influence on the recent disintegration of the Communist bloc and termination of the Cold War. A third goal was the creation of a new Canadian Pacific policy with China as a central element. It was in Canada's interest to develop political, economic and cultural ties with the countries of the Asia-Pacific region, given that area's high growth rates, Canada's need to diversify its trading patterns, and the Asia-Pacific region's long-term strategic significance. A strong Canadian bilateral relationship with the PRC would contribute to regional stability while enhancing Canadian trade objectives in the region. A fourth goal was the humanizing of Chinese communism. Increased exposure to Western ideas would break down ideological barriers, leading to the eventual democratization and humanization of the Communist system. For many Canadians this was the implicit objective underlying most bilateral programs, especially exchanges in the areas of culture and education. To the extent that China has "opened the door" to foreigners, Chinese barriers have fallen, albeit slowly, and not without setbacks, such as Tiananmen.

In the economic area, Canadian policy has focused on the diversification and expansion of trade with the PRC. Over a twenty-year period trade increased sevenfold. This may appear to be impressive, but it is worth noting that other major trading nations also increased their trade with the PRC during this period at these levels or higher. Canada has dropped from being China's fourth trading partner in the early seventies to seventh place in 1989. There has been progress in diversification, but wheat still comprises two-thirds or more of Canadian exports, and the percentage of manufactured goods sold to the PRC remains below 25 per cent. China no longer signs long-term wheat contracts with Canada; so Canada is not assured of selling its wheat annually to China, although, in fact, these sales have continued. On the Chinese side, in 1989 the PRC for the first time had a surplus in trade with Canada, due mainly to a huge rise in the export of toys and playthings which, along with textile and clothing constitute the bulk of PRC goods sold to Canada. Meanwhile exports to the PRC dropped sharply due to an anticipated decline in Canadian wheat sales due to poor Canadian crop conditions.

In culture and education Canada has emphasized programs with a human resource development and training focus. After the United States and Japan, Canada has been the third largest recipient of Chinese students and scholars. At the time of the Tiananmen "incident", over ten thousand Chinese were studying in Canada. The CIDA program has established educational linkages and helped institutions in both countries. Its China human resource development program serves as a model for other countries. In the area of immigration the family reunification program has, since 1973, moved over 40,000 Chinese to Canada to join their relatives. In facilitating the movement of people across borders, training them in Western techniques and exposing them to democratic ideas, Canada has done an impressive job in fulfilling its goals in culture and education.

One of the striking aspects of the Canadian-Chinese bilateral relationship is the vital role played by government. The "China Strategy" of 1987 refers to a "targeted, pragmatic approach", and a "coordinated team approach" to the China market. At the outset, government programs were needed to develop the cultural and educational exchanges that began the flow of people. In dealing with a centralized state economy it was often necessary to start at the government level. The PRC has preferred this method. Canadians expected government to play a key role because it has the large-scale funding essential for mounting initiatives in a country as large and centralized as the PRC. CIDA has had an enormous impact, in China and in Canada, not just for its innovative programs, but because of the large sums of government funding that have been made available to individuals and organizations in both countries. It was hoped that once the programs had been established, then private interprise or NGOs could step in and assume a major share of the cost. This never materialized. Even in the area of trade the government remains heavily involved. An enterprising Canadian corporation can utilize a wide range of government programs to pay for the cost of exhibiting wares; for feasibility and pre-feasibility studies; for assistance from the ten Canadian commercial officers posted in Beijing and Shanghai; for concessional financing to help complete the transaction. Since the mid-eighties the amount of Government government assistance has actually increased, and the Government has expanded its role in targeting large projects which involve consortia of large companies relying on special financing arranged by Ottawa.

Canada may need a new realism in its China policies and programs. The events of 1989 have provided an opportunity to reapraise what has been accomplished since 1970. After twenty years, wheat is still the main product Canada sells to China, and Canada loses money on every bushel China buys. As long as subsidized wheat constitutes nearly 70% of Canadian exports to the PRC it is an illusion that the China trade is directly profitable. Do the benefits of the bilateral relationship outweigh the very substantial costs of building and maintaining that relationship? A good part of that relationship is not trade-driven, but is based on the assumption that Canada can bring China out of isolation, can help that country "democratize" itself, and that by virtue of an "special relationship" developed over twenty years, can exercise a measure of

influence over the Chinese Government. What happened in Tiananmen calls these assumptions into question. Is the "special relationship" gone forever? The relationship can "never be the same again". But what will it be? Should Canada continue to devote so many resources in pursuit of that will-of-the-wisp, the market of 1.2 billion customers? Should Canada continue to treat China preferentially on the promise that one day the PRC will not abuse human rights and will become a more open, democratic society? Twenty years have passed and much was accomplished between the two countries. But now they have entered a more critical phase. Problems loom on the horizon: what to do with 8,000 students who do not want to go home; the question of Hong Kong's future as a factor in Canadian-PRC relations; opposition by an increasing number of Canadians to giving China special treatment. Canadian public opinion is no longer as sympathetic to the PRC as before. There are doubts about China and about Canada's assumptions and goals *vis-à-vis* the People's Republic of China. Let us hope that both countries will take these factors into account as they rebuild the post-Tiananmen bilateral relationship.

ENDNOTES

1. See B. Michael Frolic, "The Trudeau Initiative", in Paul M. Evans and B. Michael Frolic, eds., *Reluctant Adversaries: Canada and the People's Republic of China, 1949-1970* (Toronto: University of Toronto Press, 1991).
2. On public opinion, see Paul Evans and Daphne Gottlieb Taras, "Canadian Public Opinion on Relations with China: An Analysis of Existing Survey Research". Toronto: Joint Centre on Modern East Asia, *Working Paper No. 33*, March 1985.
3. Personal interview with Mitchell Sharp, June 1986.
4. See Arthur Andrew, "A Reasonable Period of Time: Canada's Derecognition of Nationalist China", in Evans and Frolic, *Reluctant Adversaries, op. cit.*
5. Personal interview with Arthur Andrew, April 1986.
6. Jacques Hebert and Pierre Elliot Trudeau, *Two Innocents in Red China* (Toronto: Oxford University Press, 1968), pp. 150-51.
7. From a conversation with Pierre Trudeau, 27 January 1987.
8. From a personal interview with Jean Luc Pepin, Ottawa, June 1986.
9. See Janet Lum, "Recognition and the Toronto Chinese Community", in Evans and Frolic, *Reluctant Adversaries, op. cit.*
10. Kim Richard Nossal, *The Politics of Canadian Foreign Policy*. Scarborough, Ontario: Prentice-Hall Canada, 1985. p. 134.
11. *Ibid*, pp. 139-143.
12. Interviews with Yao Guang and Yu Zhan, Ministry of Foreign Affairs, Beijing, 25 & 28 May 1987. (Interviews conducted by B. Michael Frolic and Jack Granatstein.)

13. From interviews in the Department of External Affairs (DEA), 1986, 1987.
14. From DEA files.
15. *Ibid.*
16. From interviews in DEA, 1987.
17. Interview with Arthur Menzies, June 1986.
18. From DEA files.
19. Interview with Ivan Head, June 1986.
20. Interview with Michel Gauvin, June 1986.
21. Interview with Mark MacGuigan, June 1986.
22. Interview with Elizabeth Racicot, CIDA, 23 May 1990.
23. From DEA files.
24. *Ibid.*
25. Interview in DEA, June 1986.
26. Interviews in DEA, June 1986.
27. Interviews in DEA, April 1990.
28. *Ibid.*
29. *Ibid.*
30. From DEA files.
31. *Ibid*, and also in interview, July 1989.
32. The author participated in this meeting.
33. See B. Michael Frolic, "The Beijing Massacre: A Canadian Perspective", (paper given at Conference on Political Order in Changing Societies, Chinese University of Hong Kong, 27 August 1989), p. 6.
34. *The Globe and Mail*, Toronto, 15 May 1990.
35. See Paul Evans, "Canada and Taiwan: A Forty-Year Survey" (in this publication, pp. 175-198).

GÉRARD HERVOUET*

Canada and Southeast Asia: An Overview of Unfinished Policies†

Ten years ago, it was still easy to outline the whole record of Canada's presence in Southeast Asia. At that time Canada was not a newcomer in the area, but it was in the process of rediscovering the importance of Asia and the Pacific. The area itself had long suffered the trauma of the Vietnam War, but the end of the conflict and the new Vietnamese threat gave a new impulse to the non-communist countries of Southeast Asia, and particularly ASEAN.

From the 1950s to the beginning of the 1970s, Canada's perception of the area was shaped by the Colombo Program and by the involvement in the International Commission for Supervision and Control in Indochina. This perception was very slow to change and may have remained the same until now among some decision-makers in Ottawa.

In 1970 when Canada reviewed its foreign policy, a White Paper was published from which a brochure dealing with the Pacific was issued. Yet nowhere in this brochure was there any mention of ASEAN. Southeast Asia was seen from the Indochinese conflict angle, and the only important member of ASEAN to be well identified as a target for future Canadian effort in that region was Indonesia. It was only in 1974 that Canadian Prime Minister Pierre Trudeau, in an article in the *Far Eastern Economic Review*, voiced his support of ASEAN but, once again, his constant reference to Indonesia followed the same trend as that of 1970. As a matter of fact, at that time, Ottawa was reluctant to agree to any strategic redistribution in the region.

In 1973, Canada withdrew from the International Commission for Supervision and Control (ICSC) of Vietnam. Having also withdrawn in 1974, from the Laos ICSC, Canada was very careful not to become involved again in situations over which it had no control. From then on, the federal government's

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only wish was to invest even more in those fields which were most likely to further Canadian interests in the region. It was therefore not altogether by chance that the first contacts between Canada and ASEAN were made in that same year. Those contacts were to grow rapidly from an initially hesitant dialogue between two partners who had for so long remained apart, to one that is today rich and teeming with new promises.

This short essay is simply to introduce to the uninitiated reader the main aspects of the state of relations between Canada and ASEAN without ignoring some aspects of our bilateral relations and the whole questions of the three Indochinese States. The first part of this paper is rather descriptive. Its objective is to sketch out a picture of the diversity of relations between Canada and Southeast Asia. The second part will concentrate more on the security challenge for Canada in the region and finally it will raise some questions that a skeptical observer always wishes to ask to people responsible for the decision and the implementation of official policies.

A BOOMING TRADE

Canada's total trade with the six ASEAN nations has undergone rather spectacular growth; since 1980, it has exceeded $1 billion. During the 1970s, Canada experienced more growth in exports to the ASEAN Nations than to any other foreign trading partner. From 1970 to 1975 the rate of growth was 8 per cent, and from 1975 to 1980 trade grew by 19 per cent. During these same periods, the corresponding figures for exports to the rest of the world were 2 per cent and 6 per cent.

In 1986 Canadian esports to ASEAN levelled off and, for the first time since significant trade began with these countries, a trade deficit was recorded. However, in 1987, Canada substantially reduced this deficit, enjoying a 39.9 per cent increase in exports to ASEAN countries. Total two-way trade amounted to $1,833 in 1987.

In 1988 for the first time the two-way trade exceeded $2 billion and the same indicator is close to $3 billion in 1989. The last two years figures are illustrative of the stronger economic performance in 1988 recorded by ASEAN. In fact, in 1988, the main source of growth in the Southeast Asian economies of Indonesia, Malaysia, the Philippines and Thailand were the recovery in primary commodity prices, strong export demand, and rapid increases in domestic consumption and investment.

Indonesia's growth — estimated at more than 4 per cent in 1988 despite the continued weakness in oil prices — reflected the success of its economic adjustment program in 1986 and 1987, and was led by the non-oil sector.[1] The recovery in Malaysia's economy, which began in 1987 after two years of stagnation, strengthened further in 1988, largely because of strong domestic demand — particularly investment demand. Exports also grew strongly — by more than 15 per cent in real terms — in response to a favourable exchange rate and firm non-oil commodity prices. The economic recovery in the Philippines, which has begun in late 1986 also continued through 1988; gross

TABLE 1: Trade between Canada and ASEAN (Canadian $ millions)

	1974			1977			1987			1988			1989		
	Exp.	Imp.	Bal.	Exp.	Imp.	Bal.	Exp.	Imp.	Bal.	Exp.	Imp.	Bal.	Exp.	Imp.	Bal.
Brunei	---	---		---	---			0,1	- 0,1	0,2	---	+0,2	2,8	---	+2,8
Indonesia	53,7	4,6	+49,1	65,8	24,6	+41,2	305,1	193,0	+112,1	298,6	179,5	+119,1	311,3	192,1	+119,2
Malaysia	29,2	61,3	-32,1	40,0	53,8	-13,8	118,4	257,4	-139,0	191,9	323,8	-131,9	218,7	320,0	-101,3
Philippines	56,1	15,7	+40,4	75,7	39,4	+36,3	122,1	132,7	-10,6	131,0	178,3	-47,3	219,4	204,7	+14,7
Singapore	29,2	51,4	-22,2	38,2	93,4	-55,2	168,0	291,4	-123,4	275,2	466,3	-191,1	242,9	503,0	-260,1
Thailand	24,8	6,6	+18,2	54,0	12,1	+41,9	194,9	209,7	-14,8	259,0	343,4	-84,4	345,3	419,8	-74,5
Total	193,0	139,6	+53,4	273,7	223,1	+50,6	908,5	1084,3	-175,8	1393,9	1528,3	-335,4	1340,4	1639,6	-299,2

Source: Department of External Affairs

domestic product growth was estimated at 6.7 per cent despite a high-servicing burden and accelerating inflation. Thailand's and Singapore's economies also recorded double-digit GDP growth with 11.0 per cent and 11.1 per cent respectively.

While two-way trade between Canada and ASEAN has tripled over the last decade, there remains tremendous potential for future growth as ASEAN and Canadian exports account for only approximately 1 per cent of each other's markets. Since 1987 Canadian imports from ASEAN have grown faster than exports, leaving a balance of trade surplus in ASEAN's favour of $335.4 million in 1988 and $299.2 million in 1989. In July 1989, Secretary of State for External Affairs Mr. Clark made mention in Brunei of the regular increase in the commercial relations between ASEAN and Canada: "Each year that I have the privilege of coming to ASEAN, I have been able to report that our bilateral trade is growing by leaps and bounds. This year ... is not different. 1988 saw another 33 per cent increase in our bilateral trade reaching a total value of 2.6 billion. This represents a 75 per cent increase in trade over the last two years alone".[2]

Despite the fact that Indonesia had been designated for almost two decades as a target in Canadian foreign po'icy, the trade figures do not reflect this priority. Indonesia's imports in 1988 were estimated to be worth some US $13.5 billion, of which perhaps $1 billion were funded under assistance programs. Canada's share is 2 per cent, at CDN $299 million in 1988 ($311 million in 1989). First, it has to be said that Canada's trade profile with Indonesia is indicative of Indonesia's lack of industrialization[3]. The proportion of commodities in imports from Indonesia is high and industrial goods make up an unusally large share of Canadian exports. Increasing imports of clothing and textiles could be a signal of the initial steps in export-led industrialization of Indonesia. Second, on the Indonesian market the competition is intense and Canadian exporters are often missing opportunities because they are not present or because they are not able to get the support of the Export Development Corporation. In 1988, by comparison, Australian exports were $578 million, UK $340 million, Netherlands $250 million, and France $464 million.

With Malaysia the picture is better. Although Canada's share of the Malaysian market has historically been about 1 per cent, Canadian technology however is comparable to the competition. In 1988, for the first time, total bilateral trade exceeded CDN $0,5 billion. The trade balance between the two countries remains in Malaysia's favour but in 1989 the gap narrowed considerably with Canadian export increasing by 14 per cent.

The combination of political and economic recession and uncertainty hurt Canadian trade with the Philippines throughout much of the 1980s, but resurgence of bilateral trade in 1987 signaled a new period of confidence and growth. Canadian exports to the Philippines expanded in 1987 after having been stagnant since 1980. Increases in sales of wheat, fertilizers and synthetic rubber and plastic accounted for most of the 1987 rise. The trade figures in 1989 indicated that Canadian exports have increased by 67.4 per cent.

Trade and economic relations between Canada and Singapore have experienced an unprecedented boom over the past several years. Bilateral trade with Canada increased by 59 per cent in 1988 to reach $742 million, putting Singapore in first place as our most important partner in ASEAN. In 1989 this ranking is no longer true since Thailand is now slightly exceeding our two-way trade with Singapore. Raw materials and commodities such as aluminum, asbestos, iron and steel, wood pulp and paper account for about half of Canada's exports to Thailand.

Canadian trade strategy has targeted Thailand as a market opportunity for telecommunication, transportation systems, the defense sector, power equipment and services and petrochemicals. Canada's persistent export marketing efforts in Thailand are also supported through a number of program activities. The Export Development Corporation, for example, is currently pursuing a number of transactions in Thailand totalling approximately $1.2 billion to facilitate Canadian participation in development projects and additional export sales. The largest transaction is currently being pursued by UTDC/Lavalin for the Bangkok Mass Rapid Transit system contract.

CANADIAN INVESTMENT

The history of foreign direct investment in ASEAN is essentially one of United States and Japanese investments. Recently investment from the European Community and newly industrializing countries (Nic's) in Asia have become increasingly important. Also Chinese investments from Hong Kong and Taiwan have taken on greater significance and are partly responsible for the Nic's large share in Thailand.

Japan is the major capital exporter to ASEAN. The overwhelming amount of Japan's FDI (Foreign Direct Investment) in ASEAN is located in Indonesia. Investment in mining represents two-thirds of Japan's Indonesian investment. Not surprising, the largest portion of Japan's investments in ASEAN is in the manufacturing sector, concentrated in labour-intensive manufacturing such as food and textile and heavy industries such as chemicals and smelting.

Although definitely more modest, Canadian investments in ASEAN follow the Japanese pattern. Even though Canadian direct investment in the developing countries grew by nearly 80 per cent to $4.9 billion between 1977 and 1981, the developing countries share of total CDIA (Canadian Direct Investment Abroad) declined from 24 per cent to 15 per cent over this period. CDIA in developing countries increased after 1985 and the share seems to remain stable.

In 1975 CDIA in ASEAN stood at $150 million, by 1986 it was almost $1.4 billion (see Table 2), a more than eight-fold increase.

The very large majority of Canadian investments in ASEAN throughout this period (90%) was (and is still) located in Indonesia. It is also interesting to note that in 1986 Indonesia was the fourth highest recipient of Canadian investment in the world after the United States $37.84 billion, United Kingdom $4.23 billion and Bermuda $1.12 billion.

Table 2. Canadian direct investment in ASEAN countries — 1980 to 1986. (Millions of Canadian Dollars).

	1980	1981	1982	1983	1984	1985	1986	%
Brunei	—	—	—	—	—	—	—	—
Indonesia	590	753	815	956	1051	1091	1112	89.89
Malaysia	127	35	42	39	50	53	45	3.64
Philippines	66	95	101	62	52	40	47	3.80
Singapore	8	-1	1	4	8	3	14	1.13
Thailand	9	16	17	31	31	30	19	1.54
TOTAL	800	898	976	1092	1192	1217	1237	100%

Source: *Statistics Canada*

Canada has a long history of participating in Indonesian mining, the most prominent being the Inco laterite nickel mine in Sosoako in South Sulawesi which began some twenty years ago. This extremely large investment dominates the Indonesian Canadian investment figures and by extension the ASEAN figures. Apart from nickel, Indonesia is a producer of tin, copper, gold and coal, the latter two minerals being of considerable interest to Canada. Canada's most prominent coal participation has been in the Bukit Asam mine in South Sumatra. Some Canadian firms are now indicating interest for the exploitation of gold in Indonesia. In the Philippines, Thailand, Malaysia, and less significantly in Singapore, the Canadian investments are concentrated on other mining activities like copper, petroleum, gas exploration and production. Canadian companies are also extending their presence in manufacturing sectors, transportation, and communication, but also in the more knowledge-intensive sectors as well. For example, Shawinigan Consultants Inc. have been involved in Malaysia for about twenty years, and Lavalin International and the Bank of Nova Scotia are very active now in Thailand.

CANADA'S PROGRAM OF DEVELOPMENT COOPERATION

Table 3 shows aggregate figures for all the development activities involving Canada and ASEAN countries, plus Burma. The disbursements cover the bilateral programs, regional programs, industrial cooperation and special programs involving institutional cooperation and non-governmental development cooperation activities.

Table 3. Disbursement profile ($ million net)

	1984-85	1985-86	1986-87	1987-88	1988-89
Burma	3,22	3,03	1,66	1,41	0,44
Indonesia	37,05	77,49	46,44	48,66	56,80
Malaysia	3,17	3,19	5,08	4,67	7,94
Philippines	8,34	8,06	16,65	29,66	31,29
Thailand	22,02	15,55	31,69	40,15	37,79
Total	73,80	107,32	101,52	124,55	134,26

Source: *CIDA Annual Reports.*

The bilateral program is currently undergoing a reorientation. In recent years ASEAN has expanded its focus from traditional development issues, such as agriculture and natural resources to encompass a broader range of development priorities. Canada's program has adapted to keep pace with these changing priorities. Since May 1987 a new approach emphasizes areas of human resource development activities in the science, technology and industrial sectors.

As to the ASEAN Program it is based on a number of principles which were proposed by ASEAN and accepted by Canada at the first Dialogue held in 1977. They are:

- assistance to ASEAN will not be at the expense of assistance to its individual member countries;
- all ASEAN projects supported by Canada will be of benefit to all member countries;
- projects should be conceived by ASEAN and have a regional character;
- assistance provided should supplement rather than substitute for ASEAN capabilities.[4]

In addition to these principles it has to be mentioned that CIDA follows certain guidelines in the selection of projects such as:

- assitance for regional projects should involve three or more ASEAN countries;
- large projects require a demonstrated commitment by ASEAN countries to a sustained regional cooperative effort, including a willingness to bear local capital and recurring costs;
- CIDA funding for equipment is primarly for Canadian-sourced components;
- assistance provided by CIDA should help to strengthen ASEAN institutional capabilities;
- projects should minimize the administrative burden on CIDA.

In 1977 two projects were accepted. First, a forest seed centre was established in Thailand to train ASEAN forestry technicians and to supply tropical tree seed stocks. A second project was to provide technical assistance in each of the ASEAN countries to further develop post-harvest fisheries expertise.

Canada's program took a new focus in May 1977 and the current activities now include the following projects: Grain Post-Harvest Program; Fisheries Post-Harvest Technology Program; ASEAN Institute of Forest Management; ASEAN-Canada Forest Tree Seed Centre; ASEAN-Cooperative Program on Development and Management of Living Marine Resources; ASEAN Energy Seminars; Satellite Communication Projects; Regional Training Program and ASEAN Canada Fund.[5]

In addition the CIDA Industrial Cooperation Program (INC) which promotes cooperation between the Canadian private sector and that of other countries, has resulted in more projects in the ASEAN area than any other region in the world. For example, Technonet Asia, which has received considerable financial support from INC since 1980, has seven of its fourteen participating organizations in ASEAN countries. This information network has begun to assist Canadian small and medium manufacturing enterprises interested in transferring their technology to ASEAN. Technonet also encourages partnerships by assisting in the selection of suitable Asian industrial partners, and with follow-up in Asia between visits by the Canadian investors to those partners.

Let us note to conclude this review that CIDA's Regional Institutions Program also supports institutions serving the ASEAN region. The objectives of this assistance to these organizations are: to foster development cooperation among countries of the region through the initiatives of regional institutions, to support human resource development efforts of regional institutions and to provide training opportunities that are responsive to regional needs; to support well-established institutions headquartered in ASEAN countries which directly benefit ASEAN nationals. Presently the program supports the following projects: the Asian Institute of Technology (AIT) Partnership Program, The Southeast Asian Ministers of Education Organization (SEAMEO), The Ryerson Asia-Pacific Institute for Broadcast Development (AIBD), and The Asian Institute of Management (AIM).[6]

THE CANADA-ASEAN CENTRE

In July 1989 the Canada-ASEAN Centre was opened in Singapore. The official objective of the Centre will be to give Canadian regional activities a sharper focus and higher profile in the region. The Centre has been designed as a catalyst for a network linking Canadian and ASEAN interest groups in a wide range of activities designed to promote better understanding between non-governmental organizations, business people and officials.

In its initial mandate, the activities of the Centre will focus on management of Canada's region-wide projects, especially the activities of CIDA. The Centre is supposed to represent the best instrument to decentralize CIDA

programs, to enhance its effectiveness and links with local development partners. Although Mr. Clark said at the opening of the Canada-ASEAN Centre that he sees: "The Centre's role in the future as building bridges between groups in Canada at ASEAN with common interests in a variety of fields as a complement to our official relations"[7], one can be skeptical about its future orientation.

People-to-people relations are very difficult and slow to implement, and their development and exchanges in the fields of education and culture are rarely a priority in the mandate structures. It is however worthy of mention to acknowledge the growing movements of transnational relations between Southeast Asia and Canada. The direct linkages of two Canadian airlines with Bangkok and Singapore have recently increased the flow of individual contacts. Consequently the Canadian government can no longer keep a record or is simply not aware of these exchanges.

The Canada-ASEAN Centre stands clearly as Canada's physical commitment to our recognition of ASEAN as a distinct entity. It will certainly be a good instrument for the improvement of CIDA's development cooperation program and the promotion of the business community's interests. But these two objectives are already broad enough and it is difficult to share Mr. Clark's optimism when he says: "I expect it will evolve with a much broader mandate",[8] or when the minister declares: "I foresee more such meetings occurring in the future: not just between our business persons but between our educators, our artists, our media and other groups..."[9]. Since the 1970s many Prime Ministers or Secretaries of State for External Affairs have expressed the same expectations[10]; until now the Canadian cultural policy record toward the ASEAN countries remains far from adequate.

IMMIGRATION

At present almost 50 per cent of new immigrants come from Asia. Among them people from Southeast Asia represented more than 30 per cent in 1989 and almost 27 per cent on 1988. Table 4 indicates that 71 per cent of the people admitted in 1989 come from the Philippines and Vietnam: the growth of applications from the Philippines is explained by the increasing demand in Canada for domestic workers.

The three Indochinese countries also remain important targets in Canadian's immigration policy. Last year in Brunei Mr. Clark recalled that "Canada was the first country to pledge to resettle refugees". He also mentioned: "... we continue in that course. At the last Conference last month in Geneva ... the Honourable Barbara McDougall pledged Canada to resettle a minimum of 16,000 longstayers over the next three years".[11] Despite the too difficult situation in Burma (or Myanmar) one could be surprised at the low figures in the Table. In fact Burma is totally ignored by the media in Canada and the absence of Canadian representation in Rangoon — since Burma is covered by Bangladesh — are among the simple explanations of the low figure recorded.

Table IV: Permanent Residents: January - December 1988; Country of last Permanent Residence: January - November 1989.

Class / Country of last residence	Family Class	Refugee	Design Class	Assist. Relat.	Entrep-reneur	Visitor	Self employ	Retired	Other indep.	Total	%
Brunei											
1988	60	---	---	51	58	5	3	3	1127	1305	6,07
1989	122	---	---	49	45	---	---	14	681	911	3,56
Indonesia											
1988	58	2	1	17	87	7	---	7	82	261	1,21
1989	70	---	1	10	40	11	7	17	101	257	1,01
Malaysia											
1988	310	---	2	58	406	15	6	16	883	1676	7,80
1989	258	1	2	57	345	5	24	37	1003	1830	7,19
Philippines											
1988	3016	2	2	1402	274	15	18	26	3555	8310	38,68
1989	2865	6	1	2220	173	81	---	27	4845	10258	40,72
Singapour											
1988	107	---	---	29	132	14	23	43	793	1141	5,31
1989	133	---	---	31	126	15	5	73	1167	1552	6,10
Thailande											
1988	114	1	24	2	5	---	1	---	7	154	0,72
1989	125	---	27	7	5	---	---	1	16	181	0,71
Vietnam											
1988	1207	2	4835	245	---	---	1	1	5	6196	28,84
1989	2490	3	4888	303	---	---	---	---	7	7701	30,27
Laos											
1988	18	---	823	1	---	---	---	---	---	842	3,92
1989	20	1	827	4	---	---	---	---	4	856	2,58
Kampuchea											
1988	46	7	1485	3	---	---	---	---	2	1543	7,18
1989	42	---	1864	6	---	---	---	---	---	1912	7,52
Burma (Myanmar)											
1988	13	---	---	20	6	---	---	---	17	56	0,27
1989	37	1	---	32	---	---	---	1	10	81	0,32
TOTAL 1988	5048	14	6872	1626	966	56	52	86	6451	21484	100%
1989	6290	12	7420	2719	736	112	36	180	7884	25438	100%

Source: Immigration Statistics Division (Compilation by the author).

CANADA AND INDOCHINA

It would be unnecessary to recall the Canadian participation in the International Commission for Control and Supervision (ICCS) in Indochina from 1954 to the end of May 1973. More relevant here is to put more emphasis on the recent and the present Canadian interest in the Cambodian conflict.

From 1975 to the end of 1978, Canada's relations with Vietnam were more or less normal. While Canada continued to have considerable reservations about the government in Hanoi it nonetheless maintained commercial relations with Vietnam and continued to provide it with development assistance, including a significant quantity of food. Several projects sponsored by non-governmental organizations continued to receive funding from the Canadian International Development Agency (CIDA). This was the case with the Canadian Save the Children Fund, the Canadian Council of Churches, Oxfam Canada, Oxfam Quebec, and the Canadian Lutheran World Relief.

It might have been expected that Vietnam's invasion of Kampuchea at the end of December 1978 would have provoked strong reactions. In fact this did not happen; the Canadian government made little comment on these developments. Surprisingly enough it was equally discreet in bringing to an end its development assistance program the following February. A Canadian election was in progress at this time and the situation in Indochina was far from being uppermost in the minds of either ministers or members of parliament. It was only at the Security Council meeting of 24 February 1979 that the Canadian representative joined his Australian and New Zealand colleagues in expressing his country's concern about what was going on.[12]

The change of government in June 1979 was marked by a hardening of the Canadian position, however. This was reflected in an increased emphasis on human rights and a desire to improve relations with China and also with the members of ASEAN, while at the same time maintaining Canada's support for the UN and for multilateral diplomacy. While the first aspect of this policy was certainly in tune with the attitudes of the time, it also echoed the principles then being advocated by the White House. Flora MacDonald, The Secretary of State for External Affairs, made no bones about her intention to "make sure that Canadian foreign policy places increased emphasis on the question of human rights" and added, "We will be on the look out for any infringements of international agreements such as the Declaration of Human Rights and the Helsinki Accord".[13]

At the same time, though the majority of the Canadian population was relatively unaware of the paradox this involved, the Canadian government attached priority to expanding its trade with China and the members of ASEAN, some which (Indonesia and the Philippines in particular) had been unfavourably criticized in the annual reports of Amnesty International.

Canadian aid to Vietnam was suspended in February[14], and on 17 September Mrs. Macdonald told the Canadian Club of Montreal that, "in light of the policy of violation of human rights that has been recently followed by Vietnam we have cut off our aid programmes to that country".[15] This speech, like many

others, made no mention of Kampuchea. In November, however, Canada was a co-sponsor of Resolution A/34/L.13 which was put forward at the United Nations by the ASEAN countries; it called for an end to hostilities, the withdrawal of all foreign forces from Kampuchea and a settlement of the dispute by peaceful means.

Canada has continued to support this resolution ever since while refusing to recognize the Heng Samrin regime in Kampuchea, which is supported by Vietnam. Like many other countries Canada finds that this places it in an embarrassing position, since in effect it seems to imply recognition of the previous Khmer Rouge regime as the only legitimate government of Kampuchea. The Canadian government tries to square the legalistic circle by its wholehearted condemnation of the genocide practiced by the Pol Pot regime.[16] In June 1982 when China and the members of ASEAN proposed the formation of a Coalition Government for Democratic Kampuchea (CGDK) which would include the Khmer Rouge, Prince Sihanouk and the former prime minister, Son Sann, Canada supported this proposal and agreed to recognize the CGDK as the only legitimate government of Kampuchea.[17]

Since that time Canada, together with China, the United States and the ASEAN countries, has taken a hard line with the government in Hanoi, in the hopes of persuading it to withdraw its troops from Kampuchea. In pursuit of this objective, and in solidarity with its allies, Ottawa has agreed to ban Vietnam from the international community. Although Canada has been more concerned with caring for the refugees, whom the Canadian population welcomed with its previous generosity (more than 130,000 Indochinese refugees), it has not been very active on the political front. Canadian policy was to continue every year to support the UN resolution calling for the withdrawal of "foreign troops" from Cambodia.

When by the beginning of 1989 Canada was indirectly approached to participate in an International Control Mechanism (ICM), it was not a total surprise. Ottawa then started to focus more attention on Indochina. Also on April 5th, Canada was formally invited to serve on an international peacekeeping body to supervise the withdrawal of troops from Cambodia. In a very carefully worded news release it was announced: "that Canada...would only consider participation if key conditions can be met including: the full support of all parties to the disputes; a clear mandate and a limited duration of involvement; manageable resources implications; and most importantly, evidence that this is part of an effective and comprehensive solution to the Cambodian problem".[18]

A few months later Canada played a very active role at the International Peace Conference on Cambodia in Paris. The Secretary of State for External Affairs participated in both the opening and closing sessions and Canada co-chaired (with India) the conference committee charged with arranging a ceasefire, putting it into place, monitoring the departure of the Vietnamese and supervising the creation of the ICM. Canada had also been prepared to contribute peacekeeping troops to the ICM. In April 1990 Mr. Clark also announced that Canada will make an advance contribution of $1.5 million to

the United Nations for its use in any eventual peacekeeping supervisory operation in Cambodia. This announcement was also anticipated by a statement: "that the Government was now in the process of re-establishing the eligibility of Cambodia, Vietnam and Laos, the three countries of Indochina for official Canadian development assistance".[19]

In March 1989 a Cabinet decision to add the Indochinese countries to the eligibility list for Canadian development assistance also recognized: "that improvement in the economic environment of Indochina will also add to the prospects for regional peace and security".[20]

The Canadian participation at the Paris Conference on Cambodia was a good opportunity to demonstrate that Canada was not totally indifferent to regional security issues. First, Canada repeated its consistent belief in, and support for, the UN and its goals. In that respect the Canadian delegation argued strongly that the United Nations should be given the central role in guaranteeing and policing a settlement. Canada also brought to the table a disinterested pragmatism, a rich experience in peacekeeping and its excellent relationship with all the Asian participants. At the Conference, Mr. Clark was also very clear in setting out the criteria for Canadian participation in a truce supervision/peacekeeping operation:

> Our earlier experience in Indochina has taught us what will not work; our experience in over 20 peacekeeping operations elsewhere gives us an appreciation of what does make for success. The mechanism should enjoy the full support and cooperation of all parties; it should have a clear mandate including the necessary freedom of action and movement, it should be charged with reporting responsibilities to a recognized international authority, it should be established on a viable financial basis, and it should be of a limited duration.[21]

Second, the Paris Conference was for the first time the real opportunity for Canada to indicate clearly its interest in the promotion of stability in the Asia Pacific region. For many years Canada has not been perceived as a serious player in the area. Our very low profile in security questions and our insistence on trade and economic questions were not good indicators that Southeast Asia was a priority region. If Canada aspires to be consistent with its repeated goals in the area, Ottawa's policies should reflect more the Asian partners preoccupations about security issues. In that respect more involvement in the Indochina peace process could be the price for a more diversified Canadian foreign policy in Southeast Asia.

CONCLUDING REMARKS

It cannot be denied that relations between Canada and the member states of ASEAN have made headway since the first official meeting with the Association in 1977. These relations have also become much more diversified and enjoy a high profile in Canada itself. Should we be satisfied with this progress? Can relations with Southeast Asia be counted on to go on improving, carried

along as it were by the irreversible momentum of initiatives already taken? To both of these questions the answer clearly is no.

Southeast Asia, as a region distinct from the rest of East Asia, is still a vague entity in the minds of Canadians. It must continually be targeted for new initiatives since nothing in this part of the world can ever be really taken for granted. Many countries, such as Japan, the USA, the EEC, and Australia, have designated it as a favoured region in their foreign policy. Competition in Southeast Asia is intense and Canada, despite the best of efforts and undeniable results, still trails far behind its competitors.

Since the beginning of the 1970s, the Canadian government has outdone the business community in its promotion of Asia. Admittedly, not all of Asia was treated in the same way since Southeast Asia has always been given a lower priority than Japan, China, South Korea, Taiwan, and Hong Kong. Thus, in regard to ASEAN, the dialogue between Canada and the Association has been marking time. Despite many gatherings and contacts, it was not until the meeting in Manilla on 25-26 May 1981 that talks were formally resumed. As Mr. Mark MacGuigan, Secretary of State for External Affairs, pointed out a month later in Singapore: "The resumption of the ASEAN-Canada dialogue after an interval of almost five years signifies in my view the opening of a new phase in the relationship between Canada and ASEAN".[22]

Beginning in 1978 and especially in 1979, there was a significant increase in activity involving Asia. Stabilization of the region's government was a contributing factor, but the second oil crisis in 1979 and the worldwide recession also generated interest in Asia's prosperity and its apparent ability to cope with those economic difficulties more easily than the West.

On the Canadian domestic scene, the New World Economic Order and changes in the North American economy encouraged the private business sector to seek out foreign markets to which it might export its products; Western Canada in particular became more aware than ever of its "Pacific" calling. As already mentioned above, the private sector lagged behind government initiatives in the 1970s. Its reluctance, however, had completely disappeared by 1979. In that same year trade soared with the five ASEAN countries, the only part of the Third World where Canada was to record an increase of such magnitude. In 1980 trade with ASEAN exceeded $1 billion — up from only $500 million two years earlier.

In order to further consolidate its interests, Canada's private sector has forged many links with the member states of ASEAN. Among such links are the Canadian Indonesian Business Council, the Canadian Business Association in Singapore, and the Thai-Canadian Business Club founded January 1990 in Bangkok. As well, the ASEAN-Canada Business Council was jointly created in December 1986 by the Canadian Chamber of Commerce in order to foster mutual understanding and promote closer commercial ties.

These links are not yet numerous enough to remedy the all too fragile nature of our economic relations with Southeast Asia. On this point the member states of ASEAN are concerned about the Canada-US Free Trade Agreement. ASEAN now perceives the North American continent much as it has the

European Economic Community. People fear not only that new obstacles will be placed in the way of products from ASEAN countries, but also that the Canadian business community will turn once again — and more so than in the past — to the United States. To this end, Canada wants to be reassuring and never misses an opportunity to consult ASEAN members with regard to the GATT negotiations. Ottawa is thus seeking to bring the members of the Association around to the position it has upheld at the Uruguay Round of the Multilateral Trade Negotiations. In addition, Canada collaborates closely with Thailand, Malaysia, the Philippines and Indonesia in the Cairns Group on trade in agriculture produce.

We are at a point in time when a possible end to hostilities in Indochina may pose a new challenge to ASEAN's solidarity and credibility. We are also in a context where the superpowers' military pull out from the region may lead to the setting-up of new regional structures. It is thus more than ever essential for Canada to formulate a specific strategy towards Southeast Asia. Such a strategy should closely harmonize economic factors and security ones as well. Canada can no longer look on passively, as before, while conflicts break out at regional or national levels. To increase its credibility, Canada must not only show its concern for regional security and stability but also strongly affirm its support for the defense of human rights and not silently condone ethnic conflicts which, inevitably, will reappear in the region with an increased acuity.

A more serious approach to ASEAN will entail an end to *ad hoc* policy making[23] and a better coordination of economic, foreign aid, immigration, educational, and cultural policies. It might be pointed out that the opening of the Canada-ASEAN Centre in Singapore will go a long way towards satisfying these needs. While this initiative is certainly worthy of praise, it is doubtful whether the Centre will reach all of the highly diverse goals set out for it. As is often the case in Canada, a new structure is created on the basis of a consensus that satisfies very different aspirations.

It has been said time and again: Canada has a very good image in Southeast Asia. Paradoxically, however, Canada is not yet well-known. While several factors can explain this state of affairs, we believe that it is above all due to a general line of conduct which is intended to be efficient yet discrete. It is our belief that Canada should be just as efficient — it not more so — and less discrete. For example, Canada's profile is so low in the Southeast Asian media as to be virtually non-existent. Outside of a number of one-time-only events, cultural and educational exchanges are few and far between.

Even within Canada it is not easy to promote interest in Southeast Asia. The informed public might believe, for example, that Canadian universities now have at their disposal substantial resources provided by the Asia-Pacific Foundation and other funding agencies to encourage the teaching of languages and to convince more students to conduct in-depth studies on this region. In fact, nothing could be farther from the truth. All too many universities, despite tireless efforts, cannot obtain the resources needed to set up new programs or simply to improve existing ones.

As we already know, the Foundation is intended to be a coordinating instrument and a forum of ideas that brings together the interests of all public and private parties. The magnitude of the tasks of the Foundation and of the expectations it has raised, has already provoked criticism and frustration. From now on, the main truth of both its policy goals and the interests it seeks to satisfy will reflect the needs of the business community. This development is well and good, even desirable. It is doubtful, however that the Foundation can satisfy the needs and interests of each region of Canada, while at the same time not undermining its efforts to promote understanding in Canada of a region stretching from Kabul to Wellington.[24]

The image that Canada is supposed to project of its diversity, its cultural duality, and its bilingual character is for all purposes absent from Southeast Asia. With regard to Indochina, for example, Canada has never taken advantage of the fact that it shares with this region a common francophone heritage. Canada has preferred to confine itself to an extremely rigid policy for the past ten years; meanwhile, some of its partners in ASEAN, despite officially hardline policies towards Vietnam and Cambodia, carry on trade with these countries. Perhaps patience is needed, given the fact that Southeast Asia still remains for Canada a new frontier: a part of the world to be discovered and rediscovered.

ENDNOTES

1. *IMF Survey*, 1 May 1989, p. 141.
2. J. Clark, "Statement at the Canada-ASEAN Dialogue meeting six plus one", *Statement* 89/34, 7 July 1989, Department of External Affairs, Ottawa, p. 1.
3. See for example *Canadian Trade with Asia Pacific: Trends and Directions*, Department of External Affairs, Kevin Shoom, Ottawa, 1989, pp. 47-50. Also of interest, *Exporter's Guide to ASEAN*, Department of External Affairs, Ottawa, 1989 and the Briefing Book for the Canadian Committee (PBEC), Department of External Affairs, 1989.
4. A. Douglas Small, "Le Canada et l'ASEAN", *Perspectives Internationales*, (March-April) 1978.
5. *Canada and ASEAN*, Published by the Canada-ASEAN Centre, Singapore, July 1989, p. 10.
6. *Ibid*, p. 9.
7. J. Clark, "Remarks on the occasion of the opening of the Canada-ASEAN Centre, *Statement* 89/35, 10 July 1989, Department of External Affairs, Ottawa, p. 4.
8. *Ibid.*, p. 4.
9. *Ibid.*, p. 3.
10. On the continuity of official statments and expectations about the diversification of Canadian policies in Southeast Asia see: G. Hervouet, "L'Asie orientale : une option régionale pour le Canada?", *Etudes internationales*,

Vol. XIV, No. 1, March 1983, pp. 59-81; or "Canada and ASEAN: Renewed Interest between two Distant Partners", *Contemporary Southeast Asia*, Vol. 4, No. 4, March 1983, pp. 509-521.

11. J. Clark, "Statement of the Six Plus Six Meeting", *Statement* 89/33, 6 July 1989, Department of External Affairs, p. 1.
12. "Canada reminds the Security Council of its Southeast Asian responsabilities", *Statements and Speeches*, No. 79/1, Department of External Affairs, Ottawa, 1979.
13. G. Hervouet, *Le Canada face à l'Asie de l'Est* (Montreal: Nouvelle optique, 1981), p. 139.
14. *International Canada*, July and August 1979, p. 189.
15. "Canada's Foreign Policy", *Statement and Speeches*, No. 79/15, Department of External Affairs, Ottawa, 1979, p. 3.
16. "The Situation in Kampuchea", *Statement and Speeches*, No. 79/24, Department of External Affairs, Ottawa, p. 2.
17. Kim Richard Nossal, "Les sanctions économiques et les petits États : le cas de la 'punition' du Vietnam par le Canada", *Études Internationales*, Vol. XVIII, No. 3, September 1987, pp. 531.
18. "Canada Invited to Serve on International Peacekeeping Body in Cambodia", *News Release*, No. 072, 5 April 1989, Secretary of State for External Affairs, Ottawa.
19. J. Clark, "Statement in the House of Commons on Canada and Indochina", *Statement* 90/05, 25 January 1990, Ottawa.
20. De Montigny Marchand, "Canada's Role in Southeast Asia in the 1990s" Chateau Montebello, Montebello, 1 May 1990, p. 8.
21. J. Clark, "Speech at the Paris Conference on Cambodia", *Statement* 89/36, 30 July 1989, Department of External Affairs, Ottawa, p. 3.
22. M. MacGuigan, *Statement*, 15th ASEAN Ministerial meeting, Post Ministerial Conference, 17-18 June 1982, Department of External Affairs, Ottawa, p. 1.
23. On this point see also Richard Stubbs, "Canada's Relations with Malaysia: Picking Partners in ASEAN", paper presented to the Joint Conference of the Candian Council of Southeast Asia Studies, The University of British Columbia, Vancouver, Nov. 1989, p. 22.
24. For a more elaborate criticism about the Asia Pacific Foundation, see G. Hervouet, "L'horizon retrouvé de l'Asie-Pacifique: un espoir de diversification", in A.P. Donneur and P. Soldatos, *Le Canada entre le monde et les États-Unis* (North York: Captus Press, 1988), pp. 66-67.

RALPH W. HUENEMANN*

Chinese-Canadian Trade Relations†

INTRODUCTION

The attitude of Western nations toward trade with China has long been dominated by two "isms": mercantilism and protectionism. Mercantilism is characterized by the belief that it is beneficial for a country to export more than it imports. The mercantilist view is implicit in such well-known slogans as "oil for the lamps of China". To cite an example closer to home, a British Columbia cabinet minister remarked in 1971 that "if 750 million Chinese could be persuaded to use toilet paper, that would use up most of all our pulp supplies and boom the pulp industry in B.C.".[1] Protectionism, by contrast, is characterized by a fear of imports, which are seen as a threat to wage levels and to jobs. To cite just one Canadian example of the protectionist view, let me quote the Montreal textile manufacturer who asked, in the context of the wheat sales to China, "How long must we subsidize fat prairie farmers by surrendering jobs in Quebec and Ontario?"[2]

Mercantilism and protectionism are not identical, by any means, but these two schools of thought often make common cause politically, since they share a deep skepticism toward trade liberalization. Lest you think that mercantilism and protectionism are unique to capitalism, let me hasten to point out that both attitudes are alive and well in the People's Republic of China.

Economists since the time of David Ricardo have been pointing out the weaknesses of both the mercantilist and protectionist points of view, but to little effect. Even we economists commonly use the phrase "favourable trade balance" when a country's exports exceed its imports, so perhaps we have lost the battle at the semantic level before we start. Nevertheless, I would like to take this opportunity to argue that neither mercantilism nor protectionism provides an adequate basis for trade policy in general or for managing the Sino-Canadian trade relationship in particular.

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† Presented at the symposium, "Canada and the Growing Presence of Asia", University of Victoria, 4 June 1990.

THE MULTILATERAL CONTEXT

The Global Scene

Before examining the details of bilateral trade between Canada and China, I would like to sketch the larger context within which this trade takes place. Globally, the successive rounds of GATT negotiations since World War II have brought about a substantial liberalization of world trade, at least where the reduction of tariffs is concerned. Non-tariff issues, however, remain extremely contentious. The current Uruguay Round of multilateral trade negotiations is struggling to find common ground on agriculture subsidies, textile quotas, countervail duties, and a variety of other issues that bear directly on Canada's trade with China. The meeting of trade ministers in Napa in May failed to break the deadlock over the key issue of agricultural subsidies,[3] and the overall outlook for the Uruguay Round is not optimistic, though of course last-minute compromise is the historic pattern in GATT negotiations.

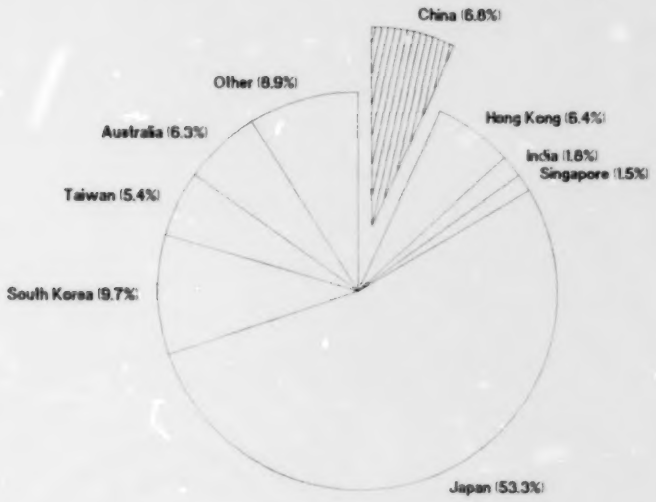
Canada's Multilateral Trade

A cursory survey of Canada's trade patterns in recent years is perhaps also useful. A decade ago, 70 per cent of Canada's merchandise trade was with the United States; last year this figure was essentially unchanged at 69 per cent.[4] As John Crosbie noted in a Vancouver speech (1989), Canada looks "north for mythology, south for commerce, east for our traditions".[5] Even without the Free Trade Agreement, this trade pattern would probably persist into the foreseeable future, though the FTA undoubtedly reinforces it. Yet if we look beyond the dominance of trade with the United States, we see that an important shift has been taking place. A decade ago about 9 per cent of Canada's merchandise trade was with Asia; by last year this figure had risen to 13 per cent.[6] Many of the economies of Asia have been growing vigorously, and not surprisingly an open economy like Canada's has shared in this growth.

Figures 1 and 2 display the details of the current pattern of Canada's trade with Asia. On the export side (Fig. 1), the most important trade partner in Asia is Japan, by a wide margin, but China, Hong Kong, Australia, Taiwan, and South Korea are all important as well. The pattern on the import side (Fig. 2) is very similar, except that Australia and Japan yield some market share to Taiwan and South Korea.

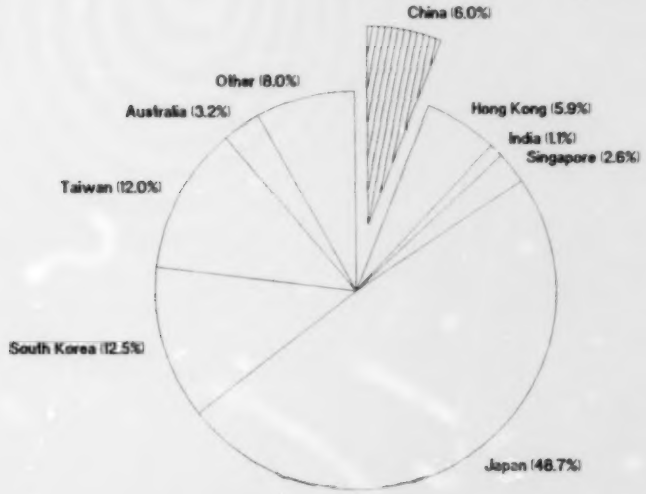
When one remembers that trade with Asia was only about 13 per cent of Canada's world trade in 1989, the stark fact emerges from Figures 1 and 2 that — on both the import and the export side — trade with China was less than 1 per cent total Canadian trade. This is not to suggest that trade with China is unimportant. $2.3 billion is not a trivial sum, even as it stands, and I believe there is room for significant growth in that figure. But it is useful to remember that a variety of other trading partners (including Taiwan) are just as important to Canada as China is.

Figure 1. Canada's Pacific Rim Exports 1989 (Total: CDN $16,426 Million)



Source: Statistics Canada, *Exports by Country*, 1989.

Figure 2. Canada's Pacific Rim Imports 1989 (Total: CDN $19,593 million)



Source: Statistics Canada, *Imports by Country*, 1989.

China's Multilateral Trade

Let me turn now to the world trade scene as it looks from the Chinese perspective. Since the historic Third Plenum in December 1978, China has been engaged in a dramatic quest for improved economic performance. To the Chinese, the key reforms of the last decade are probably the decollectivization in agriculture and the attempts to "break the iron rice bowl" in industry, although the reforms of foreign trade and investment — what the Chinese call "opening to the outside world" — are certainly also important.

I will not describe these reforms in any detail, since I am sure that you have followed their development with as much interest as I have.[7] Let me just say by way of summary that there is no question in my mind that the reforms have been real and significant, yet they have always been tinged with ambivalence. Part of the explanation for this ambivalence undoubtedly lies in the question of regional income disparities. The strategy of giving the coastal region more latitude for reform than the interior, and of giving certain small zones even more latitude than the surrounding coastal region, has always had its critics in China. Guangdong province in particular has prospered while some "have-not" provinces have lagged behind. No student of Canadian politics will be surprised to learn that these regional disparities have engendered jealousy and friction.

Another source of ambivalence toward the reforms has been the tension between plan and market. The reformers look at central planning and see rigidity, waste, and technological stagnation. For them, the market promises flexibility and efficiency. Critics of the reforms, however, still value central planning for its tight control and stable prices, and they fear what Marx called "the anarchy of the market". Most thoughtful Chinese, I suspect, see some merit in both points of view, which may explain why the reforms to date have been so hesitant and incomplete. The Chinese now characterize their system as "a planned commodity economy" — the word "commodity" in this context being a technical Marxist term that means a product bought and sold in a market. As you can see, this semantic compromise hides a fundamental contradiction.

Domestically, the success of the reforms is measured by the undeniable improvement that has occurred in the standard of living. In terms of dry statistics, real GNP per person (in constant 1988 prices) rose from about 580 yuan in 1978 to about 1280 yuan in 1988, which translates into an average annual growth of about 9 per cent.[8] Beyond the dry statistics, the increased availability of consumer goods has been evident to all, even in rural areas, though — as indicated earlier — some regions have benefited more than others.

The dark side of this success has been the double-digit price inflation that emerged about 1985 and has persisted since. (The official retail price index for 1989 showed an inflation rate of 17.8 per cent for the year, slightly better than 1988's 18.5 per cent.[9]) As inflation emerged, the regime responded with various austerity measures. At first these efforts were rather half-hearted, but a spate of panic buying and runs on bank accounts in the summer of 1988 began

to undermine the political support for the reforms and forced the authorities to react more forcefully.[10] These austerity measures, including a credit squeeze that would make John Crow envious, were eased only late in 1989, when it became clear that the economy was slipping into a serious recession.[11]

Internationally, the extent of the reforms can be measured by the rapid growth of China's merchandise trade (imports and exports together) from US $20.6 billion in 1978 to US $81.6 billion in 1989, which represents growth of about 13 per cent per annum.[12] What is perhaps even more significant than this growth of trade has been the influx of foreign investment, as symbolized by ventures like the Pingshuo coal mine in Shanxi province (with Occidental Petroleum) and the Santana automobile plant in Shangai (with Volkswagen).

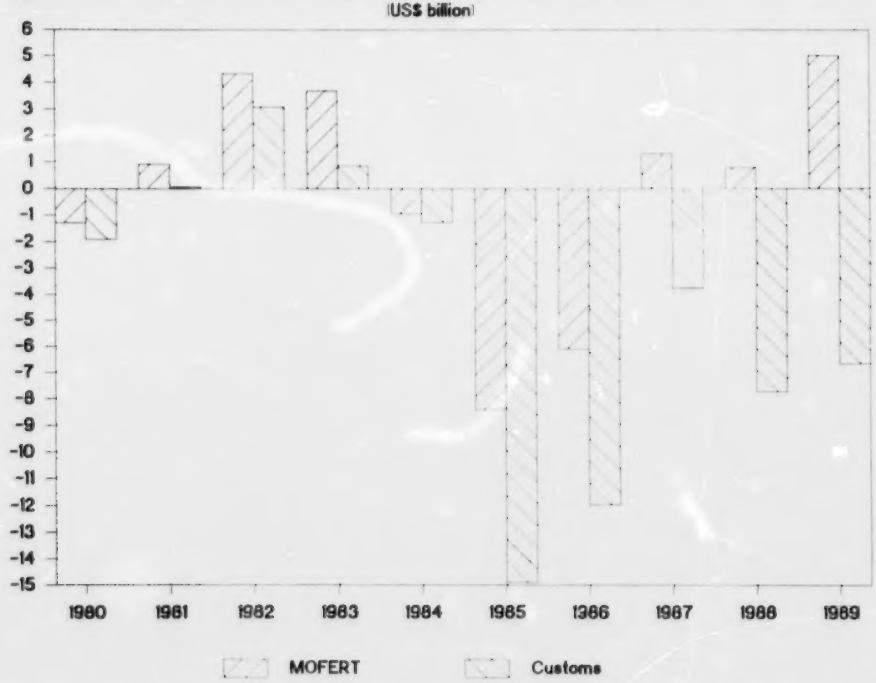
These international successes have also had their dark side, as domestic critics have been quick to point out. For some critics, the key issue has been "spiritual pollution", but for others the main concern has been trade deficits and the growth of foreign debt. The situation is summarized in Figure 3, which shows both the Minstry of Foreign Economic Relations and Trade (MOFERT) data and the Customs Administration data for China's merchandise trade balance since 1980. Until 1984 the balance fluctuated between small deficits and small surpluses, with little difference between the MOFERT and Customs data, and with the positive years outweighing the negative. Furthermore, the net earnings on invisibles were generally positive in this area, so the current account was even more "favourable" than Figure 3 suggests. Some discerning commentators in China began to argue that there was a contradiction between the announced policy of "using foreign capital" and the actual policy of running a current account surplus and building up foreign exchange reserves,[13] but most of China's leaders probably shared the mercantilist view that the pattern of China's trade up to 1984 was eminently satisfactory.

By late 1984, however, it became clear that the trade pattern was changing. Exports continued to grow, but imports surged ahead much faster, and the Customs data for 1985 revealed a deficit of US $14.9 billion. The Chinese authorities saw this as a major crisis and took vigorous steps to meet it. Exports were encouraged, imports were effectively frozen, and the merchandise account was muscled back into balance within two years. What has happened since is a bit puzzling. MOFERT thinks the trade balance has been positive, while the Customs data show rather large deficits. Faced with these conficting signals, the Chinese authorities have continued in their cautious protectionism, keeping a sharp eye on such "unnecessary imports" as motor vehicles and big-ticket consumer items.[14] The overall outcome is that in both 1987 and 1988 China's foreign exchange reserves were increased by US $4.9 billion and US $2.2 billion respectively.[15]

The Impact of Tiananmen

You will certainly have noticed by now that I have not yet mentioned the events in Tiananmen a year ago. This is because I want to emphasize that ambivalence has been inherent in the reforms from the outset; it is not something that emerged only after June 4th. Austerity measures designed to curb inflation

Figure 3: China's Merchandise Trade Balance



were already being implemented in 1988 and undoubtedly enjoyed some support from the reformers. The corrective responses to the trade deficit of 1985 were of course undertaken even earlier. Thus, some very important events and trends predate the tragedy of Tiananmen, and we should not lose sight of them.

I do not mean to suggest that Tiananmen was unimportant. Quite the contrary. I was in Beijing during Gorbachev's visit and the imposition of martial law, though I left a few days before June 4th. I spent many hours in the square, reading posters and talking to people of all ages. I will never forget the warmth of that visit, nor the brutality of the government's actions. My present purpose, however, is not to recount those events but to analyze their impact on economic events generally and on trade patterns more specifically.

What, then, has been the impact of June 4th? We should begin by noting that the Central Committee's policy statement of 9 November 1989 insists that China should continue to "deepen the reforms and open wider to the outside world".[16] But this sentence must be read in the context of the entire policy statement, which also stresses that "we should give full play to the role of big and medium-sized state-run enterprises as the backbone of the national economy", that "the leading role of the Party organization in an enterprise in political and ideological work should be enhanced", that "the planning system should be improved by appropriately enlarging the scope and proportion of products covered by mandatory plans", and that "the portion of foreign exchange earnings retained by localities and enterprises will be readjusted". In the Chinese context, these signals are pretty unambiguous, and they do not express enthusiasm for deepening the reforms and opening wider to the outside world.

The second point to be noted is that the short-term impact of June 4th on the tourism industry has been quite adverse, as one would expect. Compared to the 4.3 million tourists of 1988, only 3.2 million visited China in 1989.[17] Hotel occupancy rates have fallen to low levels, and bank loans to hotels are being rescheduled.[18] It can be argued that tourism earnings were relatively small even in their peak year of 1988 (US $2.25 billion compared to total exports of US $47.54 billion[19]), but tourism had been growing rapidly and now faces an uncertain future. As I have argued in detail elsewhere,[20] one of the key parameters that determines China's capacity to service its foreign debt comfortably is the growth rate of exports. Thus the decline of any promising growth sector must be a source of some concern, especially since two other export categories (petroleum and armaments) that have earned significant amounts of foreign exchange for China in the past have also diminished recently, though for reasons unrelated to the events of June 4th.[21]

The third point to note is that Tiananmen has had a definite impact on the flow of foreign lending and the debt situation. MOFERT reports that in 1989 "credit agreements with foreign countries" totalled US $4.8 billion, a decline of 51 per cent from 1988.[22] The most visible actor in these events has been the World Bank, which before June 4th anticipated lending US $2 billion a year to China but is now operating on a much reduced scale, limited to projects

already in the pipeline or projects that can be justified on humanitarian grounds. Commercial banks (even the Japanese banks, which are estimated to hold more than half of China's foreign debt) are also taking a cautious approach to new lending to China.[23]

In my judgment, these recent reductions of lending do not mean that China faces a debt crises of the Latin American variety. China's foreign debt (estimated by the Chinese to be US $40 billion at year-end 1988 and by the World Bank to be US $41 billion[24]) is large in absolute terms but still rather modest relative to GNP and to debt servicing capacity. By contrast to the Latin debtor countries, which blithely exceeded the conventional prudent limit of 20 per cent on their debt service ratio for at least a decade before the debt crisis of 1982,[25] China has kept its debt service ratio under control. The World Bank estimates that the ratio was in the 8-10 per cent range in recent years, while the Chinese have estimated that it has "hovered around 15 per cent".[26] China undoubtedly has the political and administrative capacity to restrict imports by rationing foreign exchange and strengthening other non-tariff barriers when balance of payments problems require it, as demonstrated after the import surge in 1985. Thus, China is not likely to default on its debt. Rather, the impact of reduced foreign lending is likely to be felt in reduced economic growth (if total capital formation is reduced) or in a squeeze on consumers (if involuntary domestic saving is increased to compensate for the diminished foreign investment).

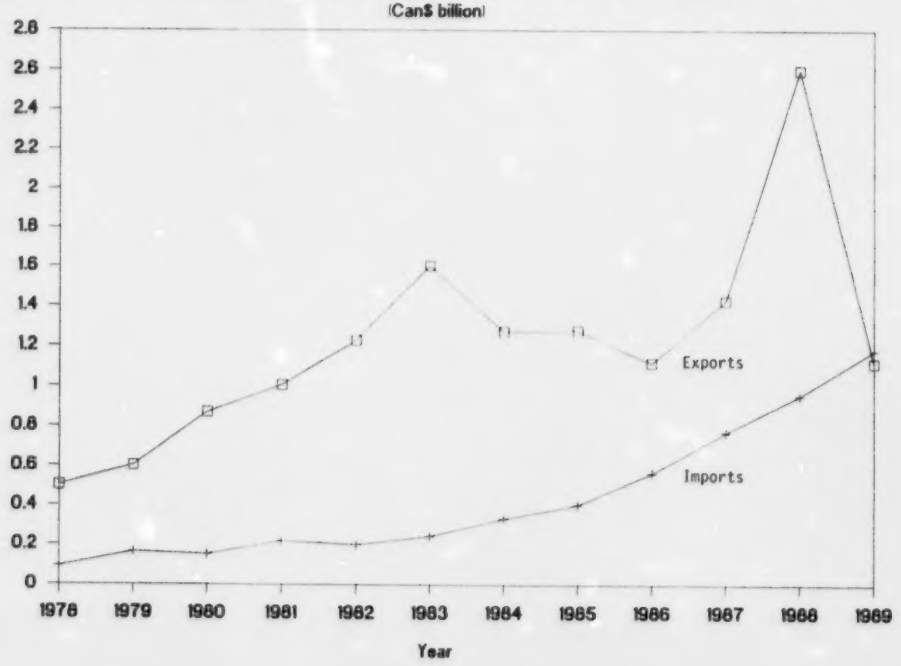
The fourth and final point to note about the impact of Tiananmen is that it has affected China's participation in the GATT process itself. When China formally applied in 1986 to resume its membership in GATT, the attitude of the other contracting parties was generally one of sympathy, albeit skeptical sympathy. That is, it was recognized that some contentious issues would need to be resolved, and doubts were expressed about the true extent of China's trade reforms to date, but a consensus in favour of Chinese membership seemed to be emerging.[27] Following the bloodshed on June 4th, however, the meeting of the Working Party on Chinese Accession that had been scheduled for July 11-13 was postponed until December, and even in December little progress was made. It now seems rather unlikely that China will be elevated from observer to contracting party status during the Uruguay Round, especially in view of Beijing's insistence that "the participation of Taiwan in GATT is first of all a political issue that will be easily resolved once China has been restored to its seat in GATT".[28]

THE BILATERAL TRADE RELATIONSHIP

Should Trade Be Balanced?

Keeping the multilateral context in mind, we turn now to the topic of Canada's trade with China. Except for the strikingly untypical year of 1989, which I will discuss later, Canadian exports to China over the years have persistently exceeded imports by a wide margin, a pattern that goes all the way back to the first wheat sales in 1960 (see Fig. 4). The Chinese have often suggested that

Figure 4: Canada's Trade with China, 1978–1989



Source: Statistics Canada, *Exports by Country* and *Imports by Country*, various years.

bilateral trade really ought to be more balanced. The Chinese perspective on this issue seems to derive in part from mismeasurement, since the Chinese Customs data show 1988 exports to Canada at about CDN $480 million,[29] while the Statistics Canada data show 1988 imports from China of CDN $956 million. Half the Chinese exports are missing from the Customs data. I suspect that the main explanation for this discrepancy is that many Chinese exports for which the final destination is actually Canada are captured in the Customs data as exports to Hong Kong. The Customs and StatsCan data for the other side of the picture (Canadian shipments to China) are reasonably congruent, so the Chinese data give an exaggerated picture of the size of the trade imbalance, though the overall fact of an imbalance can hardly be disputed.

More fundamentally, however, the question is not the precise size of the imbalance, but whether balanced trade is good or bad. To an economist it seems clear that, even at the global level, China should not be trying to achieve balanced trade if the goal of "using foreign capital" is a serious one, because this goal can only be accomplished by running a trade deficit. At the bilateral level, the argument that trade should be balanced makes even less sense, since it is generally the case that the full benefits of trade can only be attained if a country runs surpluses with some of its trading partners and deficits with others. Let me illustrate with the triangular pattern involving Canada, China, and Hong Kong. In a typical year, Canada runs a trade surplus with China, as noted, while China runs a surplus with Hong Kong, and Hong Kong in turn runs a surplus with Canada. Thus, in an important sense, the exports to China pay for the imports from Hong Kong. If trade patterns had to be balanced bilaterally, all three economies would be worse off.

That much having been said, however, it must also be admitted that at another level the Chinese have a legitimate concern: the fundamental thrust of "opening to the outside world" is to pursue a policy of export-led growth, and this can succeed only if someone is willing to buy more of China's exports. Yet we live in a protectionist world, where esoteric phrases like "countervail duty", "voluntary export restraint", and "Super 301" have become part of our routine vocabulary. The Chinese argument that trade should be more balanced is logically flawed, but if it has the practical effect of persuading Canadian politicians and populace — despite innate mercantilist or protectionist tendencies — to accept more imports from China, it probably serves a useful purpose.

The Trade Pattern in 1989

As Figure 4 makes clear, 1989 was a very unusual year in Sino-Canadian trade. Exports to China fell by CDN $1,480 million in a single year, a decline of 57 per cent. Superficially, this collapse is not hard to explain, since grain sales to China fell by CDN $1,282 million in the same period.[30] But why did the grain sales fall? The answer does <u>not</u> lie in reduced Chinese demand, because Chinese grain imports in 1989 were substantially larger than those of 1988 (US $2,983 million vs. US $1,855 million, according to the Customs data[31]). Rather, the primary answer lies in the terrible drought that afflicted the Prairies, severely reducing the supplies available for export. Extra grain from other

exporting countries, such as the United States and Australia, filled the gap for a year, but there is every reason to believe that 1989 was an anomaly and that in future Canada will regain a significant share of the Chinese grain market.

The Impact of June 4th

Following extensive consultations, the Minister of External Affairs released a four-point policy statement on 30 June giving the Canadian government's reaction to Tiananmen. Mr. Clark's four points can be summarized as follows:

1. the Chinese call for "business as usual" cannot be accepted;
2. Canada will encourage people-to-people friendship and will not become "anti-China";
3. measures that would isolate China should be avoided; and
4. Canada should coordinate its response with like-minded countries.

What is striking about this four-point stance is that, while each of the points considered separately is sensible and undoubtedly enjoys wide — though not universal — political support, the four points considered as a package are fraught with difficulty. For example, the Canadian policy of granting residency to Chinese students already in the country accords well with Point 1 but has caused the Chinese government to curtail the flow of new students, which undercuts Points 2 and 3.

Of course, Canada is not alone in its difficulties. President Bush's ambivalence toward the renewal of most-favoured-nation status for China is a case in point, as is the friction in Japan between the commercial banks and the Ministry of Finance over lending to China.[32] Point 4 is inherently difficult to implement, since it is hard to maintain a united front when "like-minded" really means "equally ambivalent".

PROSPECT FOR THE FUTURE

The economic reforms in China face an uncertain fate, since it is not easy to blend the plan and the market. If planning means old-style Soviet central planning, with direct allocation of raw materials, capital equipment and labour force, then the "two-track" system, with its parallel channels for identical commodities at two different prices inside and outside the plan, is an open invitation to corruption. On the other hand, if planning means the new-style planning of market socialism, with control over the economy exercized primarily through such levers as prices, wage rates, the interest rate, the foreign exchange rate, and the structure of taxes, the Chinese economy will undoubtedly exhibit some of the same vulnerabilities that characterize market economies elsewhere in the world: stop-go behaviour, stagflation, etc.

In sum, whether planning is old-style or new-style or some combination of the two, attempts to blend plan and market can easily trigger grievances, which in turn can quickly erode political legitimacy, as the Soviet Union and Eastern Europe have also discovered. In such dangerous circumstances, the natural

policy response is acute caution, bordering on paralysis. Bold moves in any direction are unlikely. Thus, foreign business people have little reason to fear that the reforms in China will be abandoned, though by the same token they have little reason to expect that the reforms will be vigorously expanded. The opportunities, and the difficulties, of doing business in China are little changed from what they were before Tiananmen. Patience and persistence, as always, are the watchwords.

ENDNOTES

1. I confirmed the precise wording of the quotation with the minister's office in 1971. For a paraphrased version, see the *Vancouver Province*, 9 July 1971, p. 5.
2. *Financial Post*, 10 August 1963, p. 2.
3. See "GATT Reforms Elude Trade Ministers", *Washington Post*, 5 May 1990, p. C1.
4. Statistics Canada, *Imports by Country* and *Exports by Country*, for 1979 and 1989.
5. John Crosbie, "Pacific Trade and Economic Development", in Murray G. Smith, ed., *Canada, the Pacific and Global Trade* (Halifax: The Institute for Research on Public Policy, 1989), p. 61.
6. Statistics Canada, *Imports by Country* and *Exports by Country* for 1979 and 1989.
7. Of all the monographs available on the subject of the Chinese reforms, one of the most interesting is Bruce L. Reynolds, ed., *Reform in China: Challenges and Choices* (Armonk, N.Y.: M.E. Sharpe, Inc., 1987). Another useful recent work is Jim Mann, *Beijing Jeep* (New York: Simon and Schuster, 1989).
8. Calculated from data on population and constant price GNP given in *Zhongguo Tongji Nianjian 1989* (Statistical Yearbook of China 1989), pp. 28 and 87.
9. *Beijing Review*, 2 April 1990, p. 7.
10. *Far Eastern Economic Review*, 22 September 1988, p. 70.
11. *Ibid.*, 29 March 1990, p. 68.
12. These are the MOFERT figures. The 1978 data are from *Zhongguo Tongji Nianjian 1989*, p. 633; the 1989 data are from *Beijing Review*, 12 February 1990, p. 43.
13. See, for example, Han Kexin, "Macro-Control of Foreign Exchange", in Zhang Peiji and Ralph W. Huenemann, eds., *China's Foreign Trade* (Halifax: The Institute for Research on Public Policy, 1987), pp. 25-35.
14. *Far Eastern Economic Review*, 9 November 1989, p. 60.
15. See the IMF statistics cited in David L. Denny, "The Balance of Payments After Tiananmen", *The China Business Review*, November-December

1989, p. 49. It is reported that there was also a "large increase" in foreign exchange reserves in 1989. See *Beijing Review*, 12 February 1990, p. 43.

16. See the "Decision on Further Improving the Economic Environment, Straightening Out the Economic Order, and Deepening the Reforms (Excerpt)", *Beijing Review*, 12 February 1990, pp. i-xvi.
17. For further details, see Luo Man, "Reorganizing, Assessing First-Class Hotels, Expanding Publicity", *China Market*, 4, 1990. pp. 12-13. Some of the policy proposals described by Luo, such as introducing a 10 per cent "preferential treatment service charge for foreign tourists" and discouraging price cutting by hotels and travel agencies, will surely not help the situation.
18. *Far Eastern Economic Review*, 26 April 1990, p. 54.
19. *Zhongguo Tongji Zhaiyao 1989* (Statistical Abstract of China 1989), pp. 83 and 88.
20. Ralph W. Huenemann, "Doing Business in China: What Are the Prospects?", Asia Pacific Foundation of Canada, *Issues*, III, 4 (Winter 1989).
21. Petroleum exports peaked at about US $6.7 billion in 1985, but fell to US $3.3 billion in 1988, with most of the decline explained by the collapse of OPEC prices, but with some reduction of physical quantities as well. Armaments sales are not identified explicitly in the official export data, but it is widely believed that China's massive trade surplus with Jordan, which is otherwise inexplicable, reflects entrepot trade in armaments to various Middle East destinations. Exports to Jordan peaked at US $1,341 million in 1987, but fell to US $319 million in 1989. For the detailed data, see *Zhongguo Tongji Nianjian* or *Zhongguo Haiguan Tongji* (Customs Statistics of China), various issues. See also Eden Y. Woon, "Chinese Arms Sales and U.S.-China Military Relations", *Asian Survey*, XXIX: 6 (June 1989), pp. 601-18; Daniel Sneider, "China's Arms Bazaar", *Far Eastern Economic Review*, 18 December 1986, p. 23; Quentin Hardy, "China's Oil Exports Decline as Domestic Demand Rises", *The Asian Wall Street Journal Weekly*, 12 March 1990, p. 5.
22. *Beijing Review*, 5 March 1990, p. 42-43.
23. See Cynthia Owens, "Tokyo Banks Still Keeping Purse Strings Tight, Leaving Gap in Funding for China", *The Asian Wall Sreet Journal Weekly*, 9 April 1990, p. 4.
24. *Beijing Review*, 30 Octover 1989, p. 40; The World Bank, *World Debt Tables, 1989-90: External Debt of Developing Countries, First Supplement*, Washington, D.C., 1990, p. 74. According to the State Administration of Foreign Exchange Control, China's foreign debt at the end of 1989 amounted to US $41.3 billion. See *Beijing Review*, 21 May 1990, p. 42.
25. Andrew J. Quale, Jr., "The International Debt Roller Coaster: Time for a New Approach", in William N. Eskridge, Jr., ed., *A Dance along the*

Precipice: The Political and Economic Dimensions of the International Debt Problem (Lexington, Mass.: D.C. Heath and Co., 1985), p. 238.

26. *World Debt Tables 1989-90, First Supplement*, p. 74; *Beijing Review*, 30 October 1989, p. 40.
27. For background on the issue of China in the GATT, see Kevin C. Kennedy, "The Accession of the Soviet Union to GATT", *Journal of World Trade Law*, XXI:2 (April 1987), pp. 23-40; Chung-chou Li, "Resumption fo China's GATT Membership", *Journal of World Trade Law*, XXI:4 (August 1987), pp. 25-48; and J.E.D. McDonnell, "China's Entry into the GATT", in H.E. English, ed., *Pacific Initiative in Global Trade* (Halifax: Institute for Research on Public Policy, 1990), pp. 247-63.
28. For the Chinese position, see Li Zhongzhou, "The Issue of China's Participation in the Multilateral Trade System", paper presented at a working conference on foreign trade policy issues held in Victoria, B.C., 17-20 April 1990. For alternative points of view, see Jeanne-Marie Claydon Gescher, "GATT's Problem with China", *Far Eastern Economic Review*, 11 January 1990, p. 46; Frances Williams and Jonathan Moore, "Who Goes First?" *Far Eastern Economic Review*, 1 February 1990, p. 36; and Yu-shu Feng, "One GATT, Two Systems", *Far Eastern Economic Review*, 8 March 1990, p. 48.
29. *Zhongguo Haiguan Tongji*, 1989.1, p. 15, gives the exports as US $390 million, which is equivalent to CDN $480 million at the average exchange rate for the year of US $1.00 = CDN $1.2307.
30. Statistics Canada, *Exports by Country, January-December 1989*, p. 152.
31. *Zhongguo Haiguan Tongji*, 1989.1, p. 17, and 1990.1, p. 13.
32. See Robert S. Greenberger, "Bush Finds It Harder to Defend Policy Toward China as Decision on MFN Nears", *The Asian Wall Street Journal Weekly*, 21 May 1990, p. 2; Adi Ingnatius, "Hard Line on China's MFN Status Would Hurt Its Entrepreneurs", *The Asian Wall Street Journal Weekly*, 28 May 1990, p. 2; and Cynthia Owens, "Tokyo Banks Still Keeping Purse Strings Tight, Leaving Gap in Funding for China", *The Asian Wall Street Journal Weekly*, 9 April 1990, p. 4.

M.D. COPITHORNE*

The Canada Hong Kong Relationship†

Hong Kong is unique in many ways. On the basis of its economic power, it might properly be characterized as a modern city state with a quasi international personality. Hong Kong has been a reluctant player on the world — even the regional — stage being so involved, it might be said, in making a success of everyday life. Now, events beyond its control are forcing international attention upon it and in turn, forcing Hong Kong to seek recognition and standing in the world community. Its friends, including Canada, are being asked to declare themselves as it sets out on this road.

Until very recently Canada's relationship with Hong Kong has been largely taken for granted. It was convenient for both sides; it posed few problems that needed governmental attention; it was neglected by academics. Canada officially welcomed the 1984 Sino-British Joint Declaration providing for the return of Hong Kong to China in 1997. Although China's promises of autonomy seemed generous enough, fears began to grow as the details were negotiated between Britain and China. And then came Tiananmen to draw the world's attention to what might befall Hong Kong. Now things have changed. Hong Kong affairs are making the pages of the world and of the Canadian press. The Canadian government is focusing on Hong Kong as an important political, economic and social entity in its own right and for Canada. The Joint East Asian Studies Centre in Toronto has launched a major Canada-Hong Kong research project.

Canada and China have of course been in contact for a long time. The Chinese, mainly from a few counties close to Hong Kong, began coming to North America with the California gold rush and moved northwards following the gold fever of the time. Canadians had been going to China mainly as missionaries from almost the same period. The CPR White Empresses between Vancouver and Hong Kong was the route that many took.

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1928 was an important year in the emergence of a Canadian government presence abroad. In that year Canada established missions in various cities of the world including Washington, Tokyo, Paris — and Hong Kong. This first permanent post in Hong Kong took the form of a Canadian Government Trade Commission.[1] Prior to that time there had been both trade and immigration agents but operating on the basis of contracts with the Canadian government. In the early post-war period a Canadian immigration post was also established, and in 1971 the two were combined into the newly created Commission for Canada. The primary functions of the Commission remained the same, that of promoting trade and processing immigration.

Since the early 1960s the Department of External Affairs had been appointing officers to Hong Kong, some for language training and some for political reporting, primarily China-watching. Beginning in the 1970s there was a gradual shift from a highly specialized mission to a full service one, one that offered political reporting for the Department of External Affairs, consular services for Canadian citizens, the promotion of Canadian cultural activities, police liaison, as well of course as the steadily growing immigration and trade functions. By the late 1980s the Canadian Commission in Hong Kong was one of the largest Canadian missions abroad and ranked third in Asia after Tokyo and New Delhi.

Hong Kong has also become a popular place for Canadian provinces to establish their own offices and indeed there may be more provincial offices there than in any other city in the world. British Columbia, Alberta, Saskatchewan, Manitoba, Ontario and Quebec have all established offices in Hong Kong. The Lieutenant Governor of British Columbia created a precedent when he travelled abroad to visit Hong Kong in December 1989 in a semi-official capacity.

Hong Kong for its part has had an office of the Hong Kong Trade Development Council, a quasi-governmental organization, in Toronto since 1971 and in Vancouver since 1988. In addition, the Hong Kong official in charge of the Hong Kong Economic and Trade Office in Washington, which operated under the umbrella of the British Embassy, was accredited in 1985 as a member of the British High Commission in Ottawa. Recently there has been an initiative by the Hong Kong government to open a self-standing Economic and Trade Office in Toronto. Traditionally, Hong Kong government offices abroad — other than London — were concerned exclusively with mutilateral trade policy and with the promotion of investment. Today they are increasingly concerned with a broader range of public policy matters of particular interest to Hong Kong in its own right.

In the 1990-1997 period, the Canada-Hong Kong relationship will become more and more demanding upon policy-makers. To begin with, the development of Hong Kong's international relationships is obviously made complex by the number and interests of the actors on the other side. Britain, the retreating if still touchy sovereign, and China, the prideful resuming sovereign, both take a great interest in Hong Kong's external relations. They each have their own agendas. Even when these coincide they may or may not take fully

into account Hong Kong's own interests. As for Canada and Hong Kong, they are only beginning to realize the significance of their own relationship.

Of overriding importance for Canada and Hong Kong will be the creation of a stable, formalized relationship reflecting the informal relations that have developed over the years as well as the current interests of the two communities. Post-Tiananmen, the Canadian Government seems determined to push ahead with the development of such a formalized bilateral relationship.[2]

In the trade area the two sides have little to complain of, Canadian exports to Hong Kong having finally come within sight of Hong Kong exports to Canada. In 1989, two-way trade totalled some $2.2 billion and Hong Kong investment in Canada was said to have reached $2.4 billion.[3] The number of visitors flowing in both directions continues to grow. According to Canadian figures 118,000 Hong Kong people visited Canada in 1989, and 150,000 Canadians visited Hong Kong.[4] Hong Kong continues to have some grievances primarily related to protectionist measures in the textile and garment sector but in fact Canada has become a minor target for Hong Kong compared with the EEC and Congressional legislation in the United States. The prospects for Canadian exports are likely to be heavily dependant on Hong Kong's re-export market with China, for much of what Canada sends to Hong Kong is destined for the mainland. Canadian economic interest in Hong Kong itself turns primarily on its significance as a regional finance centre. There is an impressive number of Canadian banks, trust companies and insurance companies represented in the territory, and many use Hong Kong as their regional headquarters.

In the area of immigration there is likely to be continuing pressure on Canada from the British and perhaps the Hong Kong government, to participate in a post-1977 safety net arrangement whereby significant numbers of Hong Kong people could somehow be assured of permanent Canadian residency and thus a degree of personal security. In 1989 the Canadian Chamber of Commerce in Hong Kong submitted a proposal that would have seen some such preferential treatment given to selected employees of Hong Kong companies with substantial operations in Canada. The Canadian government appears to have responded that it considered the existing arrangements to be adequate and that it was not prepared to consider an arrangement that might lead to the granting of citizenship for those who had not actually resided in this country.

For many Canadians, Hong Kong and immigration are inseparable images. The total number of immigrants from Hong Kong to Canada have fluctuated sharply over the last 19 years from a low of 3,700 in 1971 to the current figures just in excess of 22,000 which have remained stable for the last three years.[5] Traditionally, the family class was the largest category of immigrants; it was superseded in 1986 by the entrepreneurial class and both were superseded from 1986 by large growth in the independent category which in 1989 constituted 45 per cent of the total flow.[6]

In setting immigration policy, the Canadian government declares itself to be engaged in a balancing act between family reunification, the protection of

refugees, and labour market and other economic considerations. Of these the first is described as the "cornerstone of Canada's immigration program".[7] Politicians for their part seem to be particularly susceptible to representations from ethnic organizations and constituents to increase the flow of relatives of those who are already in Canada. During the 1988 election, all three political parties told the Canadian Ethnocultural Council that they favoured an expansion of the family class and this now seems to be coming about at the expense of the independent category. In Hong Kong's case, the numbers of independents are already dropping significantly.[8]

The second category that arouses interest at the political level in Canada is that of refugees. It is widely perceived that Canada has a moral obligation to receive a significant number of refugees on an annual basis. The problem is that many if not most of the persons who today claim refugee status do not readily fit within the traditional concept of the term and might more accurately be described as economic migrants. The attempts of the Canadian government to cope with the huge backlog of refugee claimants that has developed are well-known. The case of Hong Kong seems to be somewhat different. The plight of Vietnamese refugees in Hong Kong camps attracts considerable media attention in Canada and, it would seem, significant public sympathy.

In the area of refugees, Hong Kong will be looking to countries such as Canada either to accept significantly increased numbers of Vietnamese refugees or to support it in some other policy such as that of forced repatriation which will bring some respite in the physical pressure it faces on a day-to-day basis in meeting the current refugee crisis. Hong Kong has been straining to find adequate facilities for some 45,000 Vietnamese in Hong Kong claiming refugee status. Poor living conditions and ethnic unrest have led to sporadic violence in the refugee camps.

With regard to the settlement of refugees, the Canadian government sees matters a little differently. In its 1989 Annual Report to Parliament on Future Immigration Levels, Employment and Immigration Canada declared there had been "no major new outflows of refugees requiring third country resettlement".[9] However, the total number of refugees from Southeast Asia to be accepted in 1990 by Canada was increased by 500 to 3,500. Recently, Canada has been accepting Vietnamese refugees from Hong Kong in the order of 1,800 per year. On the matter of forced repatriation, Canada has a policy that sounds like forced repatriation of Vietnamese refugees by Hong Kong and other countries of first asylum, if necessary, but not necessarily forced repatriation.[10]

There are very significant numbers of Canadian citizens in Hong Kong. According to Hong Kong statistics, there are 10,000 - 15,000 Canadians there. However, many other Canadians of Hong Kong origin have returned from Canada using Hong Kong identity documents. Official Canadian estimates are that the number of persons with Canadian citizenship living in Hong Kong could be 30,000 which would make it the largest community of Canadian citizens in Asia.[11]

The Canadian government will clearly have to clarify with Beijing the status of persons born in Hong Kong or in China, naturalized in Canada and

living in Hong Kong post-1997. According to press accounts, the Chinese have so far given oral but not written assurances that such persons will be considered to be Canadians.[12]

As Canada develops its own bilateral relationships with Hong Kong, it will be contributing to the emergence of Hong Kong international personality. The Sino-British Joint Declaration provides that Hong Kong may "on its own" maintain and develop economic and cultural relations and conclude relevant agreements "with states, regions and relevant international organizations" (Article 10). This is further elaborated upon in the Annex (Section XI). Comparable provisons are to be found in Chapter VII of China's Basic Law for Hong Kong promulgated on 4 April 1990 to take effect 1 July 1997. Taken together, these suggest that Hong Kong will indeed have a quasi international personality.

By the end of 1989, the Chinese and British governments had reached agreement on Hong Kong's continuing relationship with 24 international organizations, in some cases in its own right and in others as part of the Chinese rather than the British participation.[13] A more difficult proposal for the Chinese to accept would be the idea floated at the 1989 Commonwealth Heads of Government meeting in Kuala Lumpur that Hong Kong might become an associate member of the Commonwealth. To begin with, the Commonwealth has no mechanism for associate membership; no less a hurdle is what Beijing might think of the idea. There are in fact a number of Commonwealth organizations and meetings that Hong Kong now participates in such as the Commonwealth Scholarship program, the Commonwealth Games, the Commonwealth Law Conference, etc., and it remains to be seen to what extent these links can be maintained post-1997.

In 1989, as a result of the events of 4 June in China, Hong Kong made the agendas of major world gatherings such as the Economic Summit and the Commonwealth Heads of Government meeting.[14] The Chinese bitterly objected to what they called British attempts to "internationalize" the issue of Hong Kong which they saw as a purely bilateral one between themselves and the British. In any event, such high level concern with Hong Kong seems unlikely to survive. World leaders have moved on to other matters such as Eastern Europe.

Traditionally, official Canadian interest in Hong Kong was primarily an adjunct of Canada's relations with one or both of the PRC on the one hand and Britain on the other. That this has been changing can perhaps be seen most dramatically in the high profile given to the visit by the Governor of Hong Kong to Ottawa and Toronto in May 1990. Canadian policy is now directed towards consolidating Hong Kong's participation in various international organizations and processes "in the recognition of its position as a valuable and respected, though unique, member of the international community".[15]

Within a carefully negotiated Sino-British scenario, Hong Kong has begun to enhance its international status on a bilateral basis. The first sector it tackled was civil aviation. Hong Kong's bilateral civil aviation relationships had been traditionally covered by British agreements. Often Hong Kong felt it was

playing second fiddle to British aviation interests particularly in the area of the Hong Kong-China service. The Joint Declaration allowed Hong Kong to establish its own civil aviation arrangements and the process of untangling Hong Kong from British agreements has been under way for several years. In June 1988, Canada became the third state to sign a self-standing civil aviation agreement with Hong Kong.

Canada and Hong Kong will have to enter into a variety of agreements concerning legal matters to take effect in 1997 with the lapse of various bilateral Canadian-British arrangements that have extended to Hong Kong and a number of Commonwealth arrangements. These include notably extradition, an area in which China has authorized Hong Kong to establish its own arrangements.[16] In the relatively new area of mutual legal assistance covering cooperation in the control of drugs, Hong Kong has now initialled its first such agreement — with Canada.[17] There will also be a need for a variety of civil proceedings agreements providing for service of legal documents, the enforcement of judgments, etc.

A major but largely neglected facet of the Hong Kong-Canada relationship has been that of Hong Kong students coming to Canada to continue their education at the secondary and post-secondary levels. The numbers are impressive. In the past ten years or so the number of Hong Kong students in Canada has varied between 12,000 and 18,000 a year somewhat less than half of these at the tertiary level. Currently the figure is 14,000.[18] Many of those who studied before the mid-70s were able to convert their student status and to settle in Canada. A good number of these having acquired Canadian citizenship returned to Hong Kong. The total number of Hong Kong graduates of Canadian schools and universities is officially estimated by Canadian authorities to be in the order of 70,000.[19] There are some 14 alumnae associations of Canadian universities in Hong Kong.

The process has not been without problems. Certain tertiary level education institutions in Canada have accepted significant numbers of Cantonese-speaking students and allowed *de facto* Cantonese-speaking ghettos to come into existence. The students concerned have paid a heavy price in neglecting to develop their English-language skills, and in failing to take advantage of the opportunity to learn more about Canadian society. At some institutions there exist Chinese Students Associations which provide orientation programs for newly arriving Chinese students. No doubt these are commendable exercises in self-help but they have also had the effect of keeping many Hong Kong [illegible]nts out of the regular orientation stream and thus losing an opportunity [illegible]e introduced into mainstream Canadian society.

Another problem is that of the so-called visa schools, which are schools often owned by overseas Chinese that cater to overseas Chinese students on education visas. The schools are typically neither registered not inspected by provincial educational authorities. As their standards are suspect, their graduation diploma is not usually accepted by Canadian tertiary institutions and often, they are so poorly managed as to fail financially. Such schools, located mainly in Toronto and Vancouver, are the source of periodic headlines in the Hong

Kong press and occasionally in the Canadian press as well. Their operations are in general a source of embarrassment to Canadian and provincial representatives in Hong Kong. While some efforts have been made by provincial authorities to bring this situation under control, the potential for exploitation will remain until these institutions are brought fully within the mainstream of the Canadian educational system.

Canada and Hong Kong are entering a significant new phase in their relations at both the government and private levels. Hong Kong will be seeking to stake out its autonomy internationally within the parameters agreed to between Britain and China. Canada, with its significant human and economic interests in the future well-being of Hong Kong, should be an active partner in this process.

ENDNOTES

1. For a colourful overview history of Canadian trade representation in Hong Kong, see Pigott, *Canadian Trade Commission Celebrates: 60th Anniversary in Hong Kong*, 1988.
2. See notes for a speech by the Secretary of State for External Affairs, 22 May 1990, reproduced as No. 90/29 of *External Affairs Statement Series.*
3. *Ibid*
4. Media background paper prepared by the Department of External Affairs for the visit of the Governor of Hong Kong in May 1990.
5. Canadian Commission Hong Kong Press Release, 24 January 1990.
6. Media background paper, *op cit.*
7. Employment and Immigration Canada paper entitled "Immigration to Canada: Issues for Discussion" dated 1 November 1989, p. 3.
8. Evidence of the decision to increase family class immigrants at the expense of independents is seen in the comments by the head of the Immigration Section of the Canadian Commission in a press conference in Hong Kong, 25 January 1990, an account of which was carried in the *Hong Kong Standard* the following day.
9. Employment and Immigration Canada paper entitled "Annual Report to Parliament on Future Immigration Levels — 1989", November 1989, p. 4.
10. Media background paper, *op cit.*
11. Media background paper, *op cit.*
12. James Rusk, "Red Flag over Hong Kong", *The Globe and Mail*, Toronto, 26 May 1990.
13. "Hong Kong, 1990", p. 50, being the Hong Kong Government review of annual events.
14. Group of Seven Economic Summit, July 1989 — Declaration on China; Commonwealth Heads of Government Meeting, 18-24 October 1989 — *Communiqué*, paragraph 45.

15. Media background paper, *op cit.*
16. "Hong Kong, 1989", p. 50.
17. Notes for a speech by The Secretary of State for External Affairs, *op cit.*
18. Media background paper, *op cit.*
19. Media background paper, *op cit.*

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Vancouver: A Pacific Rim City in the Making and the Hong Kong Connections that are Helping to Shape its Pacific Future†

INTRODUCTION

Vancouver has captured the broad media attention recently. There have been features on the city in such geographically wide-ranging publications as the *Los Angeles Times*, *Time*, *Business Week*, the *Boston Globe*, the *Wall Street Journal*, and of course Canada's *Maclean's Magazine*, and *The Globe and Mail*. There have been visits by television crews from Hong Kong, Toronto, New York, Los Angeles, Sacramento, Seattle, and Tokyo among others. Radio interviewers from all the major Canadian cities, from the BBC in London, and from Seattle, San Francisco and Los Angeles have also been pelting business people and academics with their queries. The issue all this attention raises, and the one addressed here is, "Why has this former milltown been the centre of so much media interest?" In finding our answer, it is argued that Vancouver is a metaphor not just for the way North America is being drawn closer to the Asia Pacific Region, but as a metaphor for the dawning Pacific Rim reality where the ocean no longer acts as a barrier to movement and economic integration. Rather the Pacific serves as both symbol and vehicle to unify the nations and economies on its eastern and western shores. Vancouver represents a prototype for this new era of trans-Pacific integration and linkage. Thus, Vancouver as prototype and as metaphor are the main foci of the discussion here.

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GLOBALIZATION: THE CONTEXT FOR UNDERSTANDING VANCOUVER'S DEVELOPMENT AND THE ROLE OF HONG KONG AND ASIAN INVESTMENT

Cities are no longer purely local creatures. They are part of the global economy. They are also vitally important parts of the Canadian political economy and of the political economy of the provinces and regions within which they are located. As a result, cities must be thought of as both affecting as well as being affected by these larger national, provincial and regional spatial units of which they are key components.

In economic parlance, urban economies are "open", meaning they are dependent to a very large degree on their ability to export goods and services to pay for needed imports. This derives from the relatively small scale of urban economies and the resulting inability to produce economically a very wide array of goods and specialized services. Openness in turn leads to considerable cyclical instability — as typified by local housing price cycles — when the export demand for the urban region's goods and services change. Urban regions therefore rely for their economic well-being almost totally on external — and typically national — economic forces and policies.

Openness has taken on new meaning however, with increasing globalization of markets. Thus, not only are urban economies subject to the vagaries of domestic economic and political forces, but they are increasingly subject to the vicissitudes of global economic, political and environmental factors.

Globalization of financial and manufacturing markets

Nations can no longer make domestic economic policy independent of the global marketplace, nor have they really been able to do so for most of the past two decades. This is equally true for firms, especially those in financial services where the globalization and integration of world financial markets proceeds at a sometimes worrying pace (Aliber 1980, Hamilton 1986, Kaufman 1986, and Wachtel 1986). Much of this integration has taken place among the developed countries of the European Community and North America, although considerable and rapid regional integration of financial markets has also been occurring in Asia (Tan and Kapur 1986, Grub *et al.* 1982, Peat Marwick Mitchell 1983, and Campbell Committee 1982). As a result of this integration there is a growing network of urban regions that have evolved as "international financial centres" (IFCs) where the world's financial decisions are increasingly being concentrated (Reed 1981). The evolution of this network of IFCs in turn suggests the growing integration of the world's major urban property markets located in these IFCs.

Looking at globalization from a more local level, one has only to look at the core of major cities anywhere in the world to see the symbols of multinational enterprise and international financial firms to get some indication of the local consequence of the gobalization of economic activity (Daniels 1986, O'Connor and Edgington 1987). Accordingly, global financial capital flows cannot and will not readily be separated from other sorts of international

investment flows even in areas long thought to be insulated such as urban property markets and the related urbanization and urban development processes (Daly 1982, Daly and Logan 1989, McGee 1984).

Globalization of property markets

A growing body of evidence suggests that the forces of yield enhancement and portfolio diversification that are driving financial and non-financial markets are leading to the globalization of urban property markets so that they are no longer the purview only of local developers and investors. Below, we review some of this evidence, which is part quantitative and part qualitative and impressionistic.

Beginning with qualitative evidence, the mass media and professional magazines carry increasing numbers of stories not just about foreign investment in Canada, but also about offshore real estate markets and the opportunities they may represent (Cu-Uy-Gam 1989, Daniels 1990, Gates 1990, Horvitch 1990, Keast 1988 and 1989, Miller 1989, Mitchell 1989, Ohse 1989, Quint 1990, Schreiner 1990, and Stoffman 1989). The Canadian experience closely mirrors that in Australia with much attention being paid to Japanese and ethnic Chinese (Livanes 1989) real estate investment activity in Australia (*Triple A* 1978), and the U.S.A. (*The Economist* 1989, Gralla 1990, Holloway 1989, *Land Use Digest* 1987, Leventhal 1987 and 1989, Rodman 1989, Roulac 1989, and *Urban Land* 1990).

Hard and fast numbers on the dollar value of offshore investment are extremely difficult to obtain since much investment is done by small investors or is done through nominees or through numbered (anonymous) corporate shells. Accordingly, it is necessary to rely on much more fragmentary, but relatively abundant, evidence to enable us to paint a general picture about the offshore investment in North American real property markets.

An article in Canada's national business newspaper suggested that in 1985 (the last year for which data were available) CDN $6.5 billion was invested in real estate or 2 per cent of total foreign investment in Canada (McKenna 1987). Americans were the largest investors followed by the British and Dutch with the Japanese back in the pack but gaining quickly (Gates 1987). Also of interest is the growing attention being paid to offshore property markets by Canadians (McKenna 1987), an essential element in the formation of truly international markets.

In Vancouver, it is estimated that ethnic Chinese have amassed about CDN $4 billion in real estate to date. A problem with numbers such as these is that it is often difficult to ascertain whether or not ethnic Chinese investment is foreign or domestic given the extensive family ties among Southeast Asian ethnic Chinese and their North American relatives.

New International Division of Labour and The Global City

The new international division of labour (NIDL) asserts that production is increasingly being organized and managed on a global scale, tying previously independent rural agrarian economies directly into the global marketplace

(Frobel, Heinrichs and Kreye 1980; and Cohen 1981). This new mode of global production is in turn closely related to the emergence of the global corporation which can: internalize many specific product markets; allocate capital globally to the most profitable locales; and finally which can (and must) gather, process and communicate information on a global scale to carry out its functions (Taylor and Thrift 1982, and Thrift 1983). These functions virtually force global corporations into cities creating global cities which in turn promote the rise of global corporations. (A similar simultaneity exists between IFCs and global corporations leading to the not surprising result that most global cities are also international financial centres or IFCs).

VANCOUVER'S EMERGENCE AS A PACIFIC RIM GLOBAL CITY: ASIAN TIES AND IMPACTS WITH SPECIAL REFERENCE TO HONG KONG

The Pacific Rim has always been an important shaper of the city's history. The founding of the city and the province were rooted in their Pacific location (see Fig. 1) (Berton 1970, Morley 1974, and Nicol 1978). The Canadian Pacific Railway and Canadian National Railways (MacKay 1986) provided physical ties and were largely constructed by ethnic Chinese. Immigration from India and Japan early this century forged further links. Thus, long before the Pacific Rim became a fashionable and current construct, Vancouver had vitally important ties with the region and was well on its way to becoming a Pacific Rim city.

Population flows and demographic change

The 1986 census for the Vancouver Census Metropolitan Area (CMA) reveals that 105,170 people (or 7.62 per cent of the CMA population) were immigrants from Asia (excluding India). The same census also shows that there were: 100,340 ethnic Chinese (7.36%); 13,955 ethnic Filipinos (1.02%); 12,100 ethnic Japanese (0.89%); 4,545 ethnic Koreans (0.33%); and 4,365 ethnic Vietnamese (0.32%). People claiming Asian ethnic origin (excluding those from India and Pakistan) account in total for 10 per cent of the CMA population in 1986. More recent figures do not exist, but it is undoubtedly the case that these figures have increased since 1986 both in absolute and percentage terms.

By looking at recent immigration, we see that Pacific Rim immigrants will increase the proportion of Asians above the levels noted above. For example, in 1988 of the 18,228 international immigrants to Vancouver, 12,805 (70.2%) came from Asia, with 4,835 (26.5%) of these coming from Hong Kong alone (Canada Department of Employment and Immigration 1989).

Vancouver's demographic structure represents more than just recent immigrants. It is the result of population movements between Asia (especially China and Japan) and Vancouver that go back a century (Chan 1983, Ward 1978, and Yee 1989). Thus, the present demographic structure is not a new phenomenon. These migration flows since the latter half of last century provide

a continuum against which Vancouver's present demographic and economic connections with the Asia Pacific region should be viewed.

Employment

It has been very difficult to obtain a good estimate of recent Asia Pacific investment (estimates up to 1989 range anywhere from CDN $2 to $5 billion). The employment impact of this investment, together with Asia Pacific migration is even harder to calculate. Nevertheless, it is fair to estimate that Asian immigrants and their funds have created and/or retained many thousands of jobs over the past half dozen years since Canada began to actively attract immigrants and immigrant investors. Of greater interest perhaps than the total number of jobs, is the diversity that is being added to the employment base of the region and the province. Thus, there is a remarkable array of new manufacturing and trading activities being created by immigrant investors from Hong Kong, Taiwan, Singapore, Malaysia, Korea and Japan (Yuen 1989).

Housing

Parallel to the efforts of local and senior levels of governments to attract East Asian immigration and investment, concern has emerged over these trends among some sections of the community. This is based upon a sense that Vancouver is changing and local citizens have little control over what is happening. Nowhere is this perception more manifest than with the issue of Vancouver's housing market in the late 1980s, where Asian money and migration has been blamed for soaring real estate prices (*BC Business*, October 1988). The average price for a single detached house in Vancouver's middle-to-upper income west side, for example, rose from about CDN $250,000 to $350,000 during 1987 to 1988 (City of Vancouver Planning Department 1989).

Analyses of this tight housing situation in metropolitan Vancouver have pointed not to overseas immigration *per se*, but to a more general mismatch between the demand for and supply of housing units (Baxter 1989, Schwann 1989). Apart from Asian migration and investment, the strong demand for housing is a result of both the general attractiveness of Vancouver as a place to live and the relative prosperity of the local job market (City of Vancouver Planning Department 1989). Thus in 1988, net migration to B.C. is estimated to have reached 46,580 people, an increase of about 45 per cent over 1987 and the largest population increase since the 1940s. In particular, net interprovincial migration from the rest of Canada rose sharply in 1988 (up by 53 per cent), after five years of overall decline consequent with the economic recession of the early 1980s, whereas net international migration increased by only 32.5 per cent in the same period (*ibid.*).

Compared to the high levels of housing demand, only about 6,000 additional single family lots were added to the supply in the Greater Vancouver area during 1988, not nearly enough to meet the increased market pressure (*Vancouver Sun*, 4 March 1989). The policy implications from these studies are clear; putting housing demand resulting from in-migration to one side,

demand for well-positioned housing in Vancouver will grow in the future, placing pressure on prices, unless the supply of houses keeps place. This will mean increased densities in highly accessible existing suburbs as well as in new developments in suburban locations.

The perception in the community remains, however, of a link between overseas investment and the local housing market. This has been sharpened through the extremely high price increases and redevelopment pressures which have occurred in fashionable areas favoured by recent Hong Kong migrants who are professional people and entrepreneurs (e.g. Vancouver's west side suburbs). Education is not unrelated to this clustering of new Asian migrants. In some of the best primary and secondary schools ethnic Chinese make up a majority of the student population (Cannon 1989).

Throughout 1989 demand increased for City Council to downzone parts of the city subject to strong redevelopment pressure. This was resisted, but in recognizing the local community's apprehension and reluctance to accept rapid rates of change, the Council introduced demolition controls contingent upon six months notice being given to tenants, or their relocation to another property, thus hoping to slow the demolition-rebuilding cycle in particular neighbourhoods (*Vancouver Sun*, 8 March, 1989). To date, neither provincial nor city government has shown any enthusiasm for controls on real estate which may adversely affect the flows of investment to Vancouver from the Asia Pacific region. In the long term it is likely that investors and immigrants from Asia (and elsewhere) will shift their investment from "passive" real estate into social housing, or more productive sectors such as garment manufacturing, which will fit better the strategic economic objectives described earlier (*Vancouver Sun*, 21 August, 1989).

Exports

Vancouver is not only Canada's gateway to the Pacific Rim, it is also emerging as an economic entity as one of the first truly Pacific Rim cities in North America. During the first quarter of 1989 as an example, and for the first time in its history, British Columbia exported more of its goods and services to the Asia Pacific Region than it did to the United States (41 per cent Asia Pacific versus 40 per cent to the United States) (Ford 1989). Additionally, MacMillan Bloedel, the province's largest company, announced that it will sell more lumber to Japan in 1989 than it will to the United States, another first (MacMillan Bloedel 1989).

Travel and tourism

Another measure of Vancouver's connections with the Pacific Rim is provided by visitors to the area (Statistics Canada 1989). A pattern similar to that exhibited in exports is emerging. Specifically, in 1978 Asian travellers represented a third (33.6%) of the 272,068 people entering Canada through British Columbia. By 1988 they represented 41.8 per cent of the 591,900. In terms of growth, whereas total travel increased by 118 per cent over this period, Asian travel grew by 170 per cent. Similarly, between 1983 and 1987 airline pas-

senger numbers from Vancouver to Hong Kong grew by 125 per cent and to Sydney, Australia, by 39 per cent, compared with less than 20 per cent growth in airline passenger travel to such established destinations as San Francisco (17.3%) and Los Angeles (13.9%). Interestingly, Vancouver-Tokyo travel remained flat, reflecting capacity limits in existing fully utilized aircraft, pointing to the exceptionally strong demand for trans-Pacific travel.

Structural change in the Vancouver and British Columbia Economies

Changes in demography, international trade and travel are mirrored in dramatic changes occurring today in the economy of Vancouver and British Columbia. These structural changes in the economic base of the province and city provide additional and growing links between the region and the Pacific Rim.

Tourism, fueled in part by trans-Pacific travel, is now the second largest economic sector in British Columbia, having overtaken the mining sector a year ago. Hotel occupancy rates in Vancouver are by far the highest of any major Canadian city, estimated at 78.5 per cent for 1989. This compares with occupancy rates in the 60 per cent range for most of the past two decades (*B.C. Economic and Statistical Review* 1989).

Closely related to tourism and travel are the increasing bilateral landing rights agreements which link Vancouver directly with Asia. During the past half dozen years such leading Asian carriers as Cathay Pacific, Singapore Airlines, Korean Airlines, and CAAC have begun flying to Vancouver direct. Canadian Airlines International and Japan Airlines have both added flights between Vancouver and Japan, while Air Canada has received rights to fly across the Pacific between Vancouver and Seoul.

Taken as a whole, services now account for 80.0 per cent of metropolitan Vancouver employment, compared with 77.3 per cent in 1981. Over that eight-year period there have been major shifts however within the service sector further illustrating the changing structure of the regional economy. Specifically, "Transportation, Communications and Utilities" declined by 16.7 per cent with its share of total employment falling from 12.0 per cent to 8.5 per cent while "Finance, Insurance and Real Estate" increased by 24.1 per cent from 7.4 per cent to 7.8 per cent of total employment while "Commercial, Business and Personnel Services" grew by 45.0 per cent increasing its share of total employment from 32.3 per cent to 39.6 per cent (*B.C. Economic and Statistical Review* 1989).

Thus, the decade of the 1980s has seen the continued relative decline of traditional goods producing industries and the continued growth of service industries, particularly those high value added services in the professions. Both tourism and professional services are increasingly servicing Pacific Rim clients, and in the process building stronger and longer-term ties between Vancouver and the Asia Pacific region.

Some Additional Points of Note

The growing focus on the Asia Pacific region from Vancouver and British Columbia is mirrored in a diverse array of cultural, educational, and research institutions being fostered in the city and the province. First, there are the programs in the primary and secondary schools in Asian language and culture. These programs are seeking to ensure that by the turn of the century, every secondary school graduate will have had either Japanese or Mandarin Chinese language courses plus courses on Asian culture and history. As currently being planned, British Columbia should have a future generation that is both comfortable and capable of realizing its Pacific Rim future.

These primary and secondary school programs are supported by major institutes of Asian research at the three provincial universities. The federally chartered Asia Pacific Foundation is also located in Vancouver and reinforces the city's primacy as a depository of Asian knowledge in Canada. The recently formed and federally and provincially sponsored Asia Pacific Banking and Finance Institute builds on these educational and research bases.

Finally, a host of business organizations have been spawned over the recent past to promote Canadian Asia Pacific trade. The Vancouver Chapter of the Hong Kong Canada Business Association, with roughly 800 members is second in size only to the Vancouver Board of Trade among local business organizations. There are also Japan-Canada, Korea-Canada, China-Canada, and Taiwan-Canada business associations which are gaining in strength and importance.

The foregoing clearly point out just how much Vancouver and British Columbia have focused on and become connected to the Asia Pacific region. These connections would have been even denser and more dramatic if we could have reviewed information on investment by Asians in the Vancouver economy, not just in real estate, but in manufacturing and services as well. Since Li Ka-Shing's purchase of the EXPO '86 site in the core of Vancouver, there has been a veritable explosion in interest and investment in Vancouver by Asians from Hong Kong, Singapore, Taiwan and Japan. Regrettably, these data do not exist. However, by all accounts these investments are significant in scale and provide further and more importantly long lasting ties between Vancouver and the Pacific Rim.

VANCOUVER: THE METAPHOR

Vancouver is already a Pacific Rim city and all indicators point to even closer links with Asia Pacific in the future. Vancouver is also a city undergoing profound and fundamental economic change which is transforming the city, now in the third year of its second century, from a regional service centre built on a natural resource base to an international service centre built on its location and high quality living environment. Interestingly, the much discussed recent demographic changes associated with increased Asian immigration are much more modest than the economic restructuring that is occurring, since the present immigration patterns are really continuations of those established over

the past many decades. The critical economic shifts are new in contrast. It is this rapid movement in uncharted economic waters that I believe is the most important issue facing the city and region in the next few years. It causes stress because it necessarily manifests itself in changing land uses (eg. luxury high rise condominiums and deluxe Asian hotel properties) and in higher residential and office densities. It is these physical manifestations which catch the public eye and ire, mistakenly to some extent, while the basic underlying economic changes and opportunities that these changes create, elude the public view.

Other places are undergoing similar change

The changes that are being experienced in Vancouver are not, however, unique to that city. The Los Angeles area in particular has experienced many of the same demographic and land use shifts, but so have other U.S. West Coast urban areas. In Canada, Toronto has received the bulk of Southeast Asian immigrants over the past decade. However, none of these places seem to have caught the media's gaze. Indeed, it is the media from many of these centres which have focused on Vancouver as a means for understanding the changes taking place in these centres. We return therefore to the question posed at the outset, "Why Vancouver?"

First, Vancouver's transformation has been very rapid. Second, since Vancouver is smaller than most of the urban centres sending media people here the effects appear larger. Thus, the impacts "seem" purer in a sense and more visible. I use "seem" reservedly since many of the impacts attributed to the growing Asian influence in Vancouver are illusory as stressed below. The most likely cause however of the extensive interest in Vancouver derives, I suspect, from how Vancouver is dealing with this growing Asian presence. In a nutshell, other areas faced with similar circumstances are more than a little interested in how we are handling ourselves in the face of this rapid change.

Backlash: The Looming $64 Question and How Well We Will Deal with the Issue

This is the crux of the issue, here and in other communities with similar demographic and economic shifts. The first question that comes to mind in this vein is "How real and extensive is the influence and how strong is it"? The answer is not simple since it depends on the neighbourhood or economic sector being examined. It also reveals that most of the locally held "truths" about Asian immigration and investment are better classified as myths. Let's look at a couple of examples to try to discern where the influence has been significant and where it has been overblown and mythologized.

Given the Asian penchant for education and the importance of the extended family it is not surprising that neighbourhoods with good schools and those favoured by other ethnic Chinese immigrants should be the focus. Thus, a number of neighbourhoods in the City of Vancouver and in selected suburbs have received the bulk of recent immigrants as well as Asian offshore investment interest. There is no verifiable evidence however, that recent immigrants and/or offshore Asian investors have had systemic effects on house prices.

Looking at the local economy, Asian immigrants and business people have had considerable impact on stimulating our local manufacturing sector, particularly in food processing, clothing, and light manufacturing and electronics (Yuen 1989). The hospitality sector (hotels and restaurants and resorts) has also received considerable attention along with much publicized plans for Asian hoteliers to develop major hotel properties in Vancouver. Finally, real estate development (as opposed to earlier and more publicized passive investment) has also been attracting growing interest, not just from ethnic Chinese but also from Japanese individuals and corporations. To date though, Asian developers are not dominant, though their role is growing and they are adding considerably to the diversity of real estate products coming onto the Vancouver market.

So much for the reality of Asian impacts. It is the myths that have garnered headlines here and in other places (including Hong Kong), and it is to these that I want to turn now.

The most widely circulated myths relate to property markets though they take a myriad of forms. Asians (immigrants and/or investors; it is never really specified in the media) have been accused of being responsible for our house price spirals, for destroying the city, for "Manhattanizing" it with Hong Kong densities. Associated claims include: "they" are buying up everything, that "they" are all rich, and that, at the rate at which "they" are going, our children will never be able to afford to live here. Finally, "they" do not contribute to our society, they only take or profit from it. Let's look more closely at these claims.

In a small nutshell, there is no evidence to support these claims aside from newspaper headlines and television stories which circulate them and give them the illusion of legitimacy on the theory that if you repeat a misleading and often outright false statement frequently enough, it will take on the trappings of truth if not become true. As noted above, house prices are driven by general economic conditions which are booming, and thus Asian buyers are not setting prices in the regional housing market. Fears of Manhattan densities are nothing new and have arisen during every economic boom and upward real estate development cycle during the past quarter century. Finally, as for contributing to our society, while slow to start the Chinese community, including recent immigrants, are rapidly becoming leading philanthropists and business and civic activists. The myths are just that.

A Scorecard: How Well is Vancouver Handling this Change?

Any balanced assessment of Vancouver's treatment of its recent changes and growing ties with the Asia Pacific region would have to conclude that we are really doing quite well. Given the speed and magnitude of the changes we seem to be absorbing them quite well. Among the most effective vehicles for smoothing the stresses associated with change have been the following. Our Lieutenant-Governor in British Columbia, His Honour David Lam, was born in Hong Kong and is one of our leading philanthropists and civic contributors. He has used his office with great effect to inform the British Columbia public

and speak about the strengths of immigration. A recently created non-profit group, The Laurier Institute, has initiated a number of studies to obtain some factual material so that we can discuss the immigration and foreign investment issues more rationally. Strong government and business support for closer ties with Asia and for continued immigration has also helped cool passions considerably. Lastly, a number of videos are being developed to inform both existing residents and new immigrants about their mutual responsibilities. Information is the key and much good information is starting to be developed and disseminated. The future should look considerably better in this vein than the ill-informed recent past.

CONCLUSION

Vancouver is a city undergoing rapid economic and demographic change. The pre-1986 economic and social order are probably gone forever. Change is stressful. People want to understand their world and using Asians and Asia as an explanation (i.e. scapegoat) helps in some sense. It is far more helpful though, to understand the deeper seated structural changes, and to work with other people to see how these changes can represent opportunities for all of us and our children (i.e. gains), not just losses through changes in existing comfortable ways. This is the real and deep underlying metaphor and this is ultimately what Vancouver may be able to share with the world: how to cope with economic and demographic change while becoming a prototype for the future: A North American Pacific Rim City.

BIBLIOGRAPHY

Aliber, Robert Z., "The Integration of Offshore and Domestic Banking Systems", *Journal of Monetary Economics*, 6 October 1980, pp. 509-526.

Baxter, D., *Population and Housing in Metropolitan Vancouver: Changing Patterns of Demographics and Demand*. Vancouver: Laurier Institute, 1989.

Berton, Pierre, *The National Dream: The Great Railway, 1871-1881*. Toronto, Ontario: McClelland and Stewart, 1970.

British Columbia Ministry of Finance and Corporate Relations, "British Columbia Economic and Statistical Review". Victoria, British Columbia: B.C. Ministry of Finance and Corporate Relations, 1989.

Campbell Committee, *Australia Financial System Inquiry: Commissioned Studies and Selected Papers*, Parts 1 and 2. Canberra, Australia: Australian Government Publishing Service, 1982.

Cannon, Margaret, *China Tide: The Revealing Story of the Hong Kong Exodus to Canada*. Toronto, Ontario: Harper and Collins, 1989.

Cohen, R.B., "The new international division of labour, multinational corporations and the urban hierarchy". In M.J. Dear and A.J. Scott, eds., *Urbanisation and Urban Planning in Capitalist Society*. London, England: Methuen, 1981.

Chan, Anthony B., *The Gold Mountain: The Chinese in the New World*. Vancouver, B.C.: Asia Pacific Initiative, 1988.

Cu-Uy-Gam, Miriam, "Offshore cash helps lay foundation for property deals", *The Financial Post*, 6 November 1989, p. 33.

Daly, Maurice T., *Sydney Boom, Sydney Bust*. Sydney, Australia: Allen and Unwin, 1982.

Daly, Maurice T. and M.I. Logan, *The Brittle Rim: Finance, Business and the Pacific Region*. Sydney, Australia: Penguin, 1989.

Daniels, Alan, "Tokyo firm buys into CP hotel: 80% of Chateau Whistler reported sold for $80 million", *Vancouver Sun*, 15 March 1990, p. C1.

Daniels, Peter W. "Foreign Banks and Metropolitan Development: A Comparison of London and New York", *Journal of Economic and Social Geography*, Vol. 77, No. 4, pp. 269-287, 1986.

Department of External Affairs, "Pacific 2000 News Release", 16 October 1989.

The Economist, "Japanese Property: A glittering sprawl", pp. 25-28, 3 October 1898.

The Economist, "Japan's big property grab", pp. 85-86, 3 October 1989.

Ford, Ashley, "Asia Top Market for B.C.", *Vancouver Province*, 30 June 1989.

Frobel, F.J., J. Heinrichs, and B. Kreye, *The New International Division of Labour*. Cambridge, England: Cambridge University Press, 1980.

Gates, Bruce, "Land prices lure Japanese", *The Financial Post*, p. 7, 3 August 1987.

_____, "Study state laws before investing in U.S. property", *The Financial Post*, p. 37, 19 March 1990.

Gralla, Heidi, "Developers eye Europe; Simon in Hungary", *Shopping Centers Today*, March 1990, pp. 3 and 26.

Grub, Phillip D., Tan Chwee Huat, Kwan Kuen-Chor and George H. Root, *East Asia: Dimension of International Business*. Singapore: Prentice Hall of Southeast Asia Pte Ltd., 1982.

Hamilton, Adrian, *The Financial Revolution*. New York, N.Y.: The Free Press, 1986.

Holloway, Nigel, "Japanese funds inflate Hawaii's property bubble", *Far Eastern Economic Review*, 3 August 1989, pp. 48-51.

Horvitch, Sonita, "Prime Toronto real estate draws foreign investment", *The Financial Post*, 19 March 1990, p. 44.

Kaufman, Henry, *Interest Rates, the Markets, and the New Financial World*. New York, N.Y.: Times Books, 1986.

Keast, Gordon, "The World's Longest Commute", *Equity*, March 1988, pp. 22-29.

_____, "The House of the Rising Son", *Equity*, May 1989, pp. 78-79.

Land Use Digest, Volume 20, Number 11, 15 November 1987, "Land Prices in Tokyo Increased by More than 85 Percent", (p. 3) and "Japanese Investment in U.S. Real Estate is Expected to Double", (p. 4).

Leventhal, Kenneth and Company, *Real Estate Newsline*, Volume 4, Numbers 7 and 12, July and December 1987.

_____, *1988 Japanese Investment in United States Real Estate*. Los Angeles, CA: Kenneth Leventhal and Company, 1989.

Livanes, George, "A Review of Acquisition of Real Estate by Chinese in the Haymarket Area of Sydney", M.A. Thesis. Department of Geography, University of Sydney, Australia, 1989.

MacKay, Donald, *The Asian Dream: The Pacific Rim and Canada's National Railway*. Vancouver, B.C.: Douglas and McIntyre, 1986.

MacMillan Bloedel, "Information for News Median", 11 August 1989.

McGee, Terence G., "Circuits and Networks of Capital: The Internationalization of the world economy and national urbanization". Vancouver, B.C.: The Institute of Asian Research, The University of British Columbia, 1984. Mimeographed.

McKenna, Barrie, "Foreign rush to Canada could turn to torrent," *The Financial Post*, Property Post Special Report, pp. 43-44, 23 November 1987.

Miller, Rich, "Japanese real estate group buys Houston skyscrapers", *The Financial Post*, 3 November 1989, p. 8.

Mitchell, Alanna, "Canadian real estate joining global", *The Financial Post*, 10 April 1989, p. 14.

Morley, Alan, *Vancouver: Milltown to Metropolis*. Vancouver, B.C.: Mitchell Press, 1974.

Nicol, Eric, *Vancouver*. Toronto, Ontario: Doubleday Canada, 1978.

O'Connor, Kevin and David Edgington, "Producer Services and Metropolitan Development in Australia", Department of Geography, Monash University, Clayton, Victoria, 1987.

Ohse, Hisanobu, "Japanese investors buying up property in southern California", *The Financial Post*, 1 August 1989, p. 6.

Peat, Marwick, Mitchell Services, *Market Intelligence Report-Sydney: Financial Growth Centre for the Pacific*. Sydney, Australia: New South Wales Government, August 1983.

Quint, Michael, "Japanese expand real estate lending as U.S. banks retreat from market", *The Globe and Mail*, 19 March 1990, B6.

Reed, Howard Curtis, *The Preeminence of International Financial Centers*. New York, N.Y.: Praeger Publishers, 1981.

Rodman, Jack, "Japanese investors expected to invest more in residential development in U.S.", *Real Estate Newsline*, Volume 6, No. 5, pp. 1, 7-8, May 1989.

Roulac's Stategic Real Estate, "Japanese Lead Foreigners in U.S. Megadeals", Volume 10, Number 1, pp. 6-7, January 1988.

Schreiner, John, "Japanese infatuated with investment in Canada", *The Financial Post*, 20 March 1990, p. 13.

Schwann, G.M. *When did You Move to Vancouver? An Analysis of Migration and Migrants into Metropolitan Vancouver*. Vancouver, B.C.: Laurier Institute, 1989.

Statistics Canada, "Non-Resident Travellers Entering Canada via British Columbia", *Bulletin 66-001*, various years through 1989.

Stoffman, Daniel, "Asia Comes to Lotusland", *Report on Business*, November 1989.

Tan, Augustine H. H. and Basant Kapur, eds., *Pacific Growth and Financial Interdependence*. Sydney, Australia: Allen and Unwin Australia, 1986.

Taylor, Michael and Nigel Thrift, eds., *The Geography of Multinationals*. London, England: Croom Helm, 1982.

Thrift, Nigel, "World Cities and the world city property market: The case of Southeast Asian investment in Australia", Working Paper, Australia National University, Research School of Pacific Studies, Department of Human Geography, 1983, mimeo.

Triple A, "Special Survey—Property 1987", pp. 88-103, August 1987.

Urban Land, *Real Estate Capital Flows*, Volume 49, Number 1, January 1990, pp. 32-33.

Wachtel, Howard. *The Money Madarins: The Making of a Supranational Economic Order*. New York, N.Y.: Pantheon Books, 1986.

Ward, Peter, *White Canada Forever*. Montreal, Quebec: McGill-Queen's University Press, 1978.

Yee, Paul, *Saltwater City: An Illustrated History of the Chinese of Vancouver*. Vancouver, B.C.: Douglas and McIntyre, 1989.

Yuen, Nelson, "An Observation on Business Investments of New Immigrants", *The Chinese Edition*, October 1989, pp. 32-33.

JAMES O. CASWELL*

Some Influences of Chinese Art on Canadian Art?†

This session, "Asian Influences on Canadian Art", could be dealt with very simply: there are no Asian influences, at least important influences, on Canadian art. Thank you very much.

However, there are some issues here which may be of interest as one searches for an explanation — or defense — of this observation. Given the sheer size of Asia, its huge population and its long cultural history, particularly in the realm of visual art, it may seem altogether curious that so little of its art has made much of an impact on western art generally, let alone Canadian art in particular.

Certainly there has been a long history of contact and trade between East and West, and this includes kinds of things which may be called visual art. The Romans traded for Chinese silks with the Han Chinese some 2,000 years ago and, later, Chinese pottery and porcelain was coveted world wide. But the fundamental reason for this was the superior technology of these media which the Chinese had long developed, and this endowed both silk and ceramics with commercial value beyond any consideration for art as such.

At the time, the West found some enchantment in not only the masterful craft of Chinese ceramics but also in the quaint and exotic decorative patterns on them. And, coincidental with the Ming and Qing Dynasties in China, Europe developed a fondness for quasi-Chinese gardens, architecture and decorative art of other kinds, especially since the seventeenth century.

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It is important to note again that there was very little understanding or appreciation of the history of these forms of Chinese craft art, their social function or their cultural context. Instead, there was a fascination for only exotic *chinoiserie* insofar as it matched a European taste for elaborate ornament. At the same time, this would-be international stretch of taste confirmed western imperial notions of world domination where the world, particularly the Asian and most especially the Chinese world, served only as a source for visual pronouncements and confirmation of European power and wealth.

While western artists occasionally have found inspiration in Asian art, there is always a question whether their attraction was visual *and* intellectual or just the former. The Impressionists (such as Van Gogh) of the late nineteenth century copied Japanese prints of a nearly contemporary time, and they sometimes worked Japanese motifs as secondary design elements into their paintings. Contemporary artists, such as the Americans Franz Kline and Robert Motherwell, have found some kinship with the gestural brushwork of Japanese Zen painting. Mark Tobey and Morris Graves, Seattle artists who have some secondary standing in the art world, were influenced by Asian calligraphic practices and other aspects, and both sought understandings beyond just the formal in, however, a rather naïve way. The well-known Canadian artist Toni Onley has considerable sympathy for Asia, particularly Japan, though how much effect this has on his art is uncertain.

This long history of artistic trade between East and West is a fitful one. It is also largely a one-way street. While the Chinese too have long dealt with foreign lands, they have not had much concern for foreign culture, including art culture. When the foreign religion of Buddhism made its impact upon China, its art was transformed into a Chinese idiom. Or, there is a continuing debate as to the importance of western pictorial notions in Chinese painting from the seventeenth century and later. If there is this influence, it was very much transformed by Chinese expressive means and ideas. There is no denying that the Qing court found amusement in western painting as promoted by the Italian missionary Castiglione (known by his Chinese name, Lang Shining); but it is doubtful that this was any more profound than an equal enthusiasm for bizarrely ornate, western-inspired clocks in the court.

At one perhaps too simple level, both western and Chinese artists have engaged in nothing more than visual dabbling (or possibly babbling) when it comes to dealing with foreign sources. The answer to this, to put it in equally stark terms, is that western and Chinese artists have worked within closed systems.

Yet there is an important tilt here: we can speak of western art in a much more inclusive way as it has been defined in a more inclusive way — painting, sculpture, architecture and so on, and serving very diverse clienteles over the ages. It has thus come to represent a *lingua franca* extending at least from Greek and Roman times to the modern West, including Europe and the Americas. Obviously much time and change on any number of social, political, cultural and economic fronts are involved here. But, in one way or another,

western art — broadly defined — has been a public art with which all are familiar.

The Chinese situation is very different. If we accept the narrowest Chinese definition of art, that is calligraphy and painting, the whole rich experience has been the secret preserve of a limited few. It is thus relatively easy for westerners to acquire craft art and the like from China, often being an economic resource for the Chinese (ceramics being the best example); but this does not represent the standard by which the Chinese have measured their *intellectual* achievements in art and which, until recent times, the literary elite who made and owned paintings kept to themselves.

If art of any form has human thought as its ultimate point, then it is no wonder that neither the westerner nor the Chinese has truly penetrated this understanding. The ethnocentric Chinese did not care, and the westerner was simply locked out.

Perhaps things are now changing. Last fall the Chinese Cultural Centre in Vancouver mounted an exhibition which was entitled *In Transition: Chinese Canadian Artists in Vancouver*. The theme of this exhibition was ostensibly simple: what impact did the Canadian experience have upon artists of a Chinese background? The exhibition included some 39 artists which alone resulted in a great visual diversity. The catalogue summarized the backgrounds of the artists, noting their wide range of ages (25 to 77) and the diversity of the places where they were born (including Canada) and the education they had.

The catalogue goes on to note that some of these artists (who are generally older) "look in" to Chinese traditional modes of painting and calligraphy, others "look around" to seek some accommodation between Chinese and western values, and yet others (usually younger) largely abandon overt Chinese values — though not necessarily themes — and "look out" to work in western artistic modes. These same general tendencies can be seen among Chinese artists in many other places, even in China itself. Thus, it might be useful to consider briefly these separate categories relative to their current position in the worlds of art and their possibilities for having a greater impact in the contemporary scene beyond the cultural borders of China.

Calligraphy remains the quintessential art of China. Only in relatively recent times has it come to gain some appreciation and understanding in the West, first through scholarly professionals and then through several exhibitions. There is some appeal to the untutored western eye in the seemingly abstract graphic shapes of the characters and in the complexities of expressive line which constructs them. Yet to stop at that is to miss most of what Chinese calligraphy is all about. It is concerned with text and image, something which many current western thinkers would appreciate, yet it is also strongly anchored in an historical consciousness. It is an art of communication in the double sense of linking contemporary sympathetic spirits and going back through time to venerable poets and calligraphers.

The complexities of brushwork, language and history which are critical to the understanding of calligraphy are daunting enough to the western viewer, but there is another deterrent to gaining access. Traditionally, and even now,

calligraphers, such as a lively group in the Vancouver area, speak largely only among themselves and exchange their works within the same tight group. Calligraphy may represent a life style of the educated elite, but it does not — and properly should not — represent a means of livelihood. The system for the Chinese calligrapher, then, remains closed. This may well be necessary for otherwise the life-giving force of Chinese cultural values might be lost or at least weakened.

The situation for the Chinese painter of landscapes and other images is more troubling today. Certainly there are many still who, like the calligrapher, remain attached to traditional values and lineages. But their presence and influence seems to be much diminished now. This may be inevitable when Chinese artists are exposed to international ideas, but it seems to be true for China itself (excluding other Chinese communities in Asia beyond China). What seems to be happening is that traditional Chinese painting has been co-opted by the state, and this has changed things radically. This goes beyond Chairman Mao's Yan'an Forum injunction of 1942 that art must serve the masses, itself a radical change of traditional notions. Rather, it seems art must now serve the state from which, as we have recently seen so clearly, the masses are still excluded.

Oddly enough, painting in China today is not so blatantly propagandistic as it was at mid-century. Instead it is often pathetically bland: images of repetitive landscapes, ink-splash camels and pandas, posturing heroes of folklore and the like. It is altogether more art for the tourists than art for the masses, for the Chinese masses have never had much access to art of imperial definition, however used. The state probably deliberately promotes this — and makes it a bureaucratic wing of government through such as the Chinese Artists' Association in Beijing — in order to arbitrarily increase the commercial value of the art internationally and thereby gain hard currency. Why else would there be the big splash given to the 12-year old artist Yani who, however precocious, was honoured with a huge exhibition together with a lavish catalogue, currently on view in major American institutions? Perhaps much of this painting has become nothing more than the same kind of export commodity to the barbarians that silk was for the Han — and as ephemeral.

The grim reality may come to be that the Humpty Dumpty of Chinese art today has been split into too many parts to ever become whole again. Lonely practitioners of the old ways (and even these may have become internally sapped of creative energy), subsidized artists of the state, and, not to be ignored, painters of a largely western sort all comprise what is happening in China now. Art is important not because artistic debates are going on in any lively fashion, but rather because political ones are — or not, after Tiananmen Square.

Traditional Chinese artists beyond the reach of continental politics face some of the same problems as they too have been cut off from what once sustained them. The reasons, however, are different. They simply lack the "critical mass" of artistic society that has been so critical in the history of

Chinese painting. Yet the results are not so dismal as relative freedom itself sometimes keeps the creative juices flowing.

Still these artists are threatened with contamination too — like their continental peers but, again, for different reasons. The relative freedom allows explorations of a diverse kind; but these in themselves lead to the incorporation of values which may be basically inimical to what Chinese art, visually and intellectually, is all about. Maybe this is, or will come to be, a good thing, but thus far there is more the sense of an oil-water mix than the coherent synthesis to which these Chinese artists *seem* to aspire. While one may often find the "pretty picture" and even be seduced by it, there is as often a certain hollowness to it when it is not predicated upon some intellectual framework.

There is that third kind of Chinese artist, the one who "looks out" and either shuns or simply pays no heed to the formal values of Chinese art as such. But, as briefly mentioned before, this is not to say Chinese themes and concerns are cast out at the same time. In general, these artists accept that the world, at least their world, is much more than China; yet they need not deny the fact that somewhere and somehow they are Chinese. This is indirect testimony to the cultural strength of China and what it has produced among its people, particularly a pride in one's ancestry and a reliance upon the family.

This artist is the product of the twentieth century. Prior to Liberation, many Chinese artists travelled abroad, particularly to Europe. Some returned, and others stayed. Xu Beihong was among those who returned to become a cog in the official establishment, and his pupil, Wu Zuoren, is today Chairman of the Chinese Artists' Association. Zhao Wuji (Zao Wu-ki/Chao Wu-chi) stayed on to become a figure of some note in Paris. While lumped with non-representational artists, his paintings contain Chinese subject matter in subtle ways. One constant characteristic of Chinese painting is that it will be readable, that one can give identifying words to its subject matter, or that it "depicts forms according to their natural appearance", to paraphrase one of the six principles of Chinese painting enunciated by Xie He some 1,500 years ago. In this Zhao Wuji remains Chinese, but the language of expression is western.

The whole question of "readability" has become a significant issue in current art discussions. Art, it is said, cannot have or retain its value if it is tightly sealed within purely formal values — being only wallpaper, as it were. Instead, it must actively participate in its context. Art of the state, even that of modern China in a feeble way, does this overtly, but individuals may — if they are allowed to do so — take a more critical stance to the times and places in which they live. When artists, whether Chinese or western, first open their minds to their concerns and, second, seek to transform them into visual statements, then art truly again has a role to play in civilization. Some Asian, some Chinese artists are now doing this.

This paper began by baldly stating that there were no important influences of Asian art, at least of a durable kind, on western art, particularly Canadian art. This remains formally true in spite of occasional brief forays into mixing East and West. But art is the product of mind, and here at last we come to see the importance of Asia in the formation of today's art — and this might be

particularly true for Canada. Asian experience is no longer the sole property of Asia, any more than western experience is that of the West. What Asia now brings is people and their cultural background, and that unquestionably has had an impact which will surely increase in times to come.

Convenient examples may be found on the faculty of the Fine Arts Department at The University of British Columbia. Jeff Wall joined the Department three years ago, and Ken Lum will join it this fall. Professor Wall has been called Canada's most significant contemporary artist, and he has an international record of exhibitions and critical attention. Ken Lum is a native-born Canadian of Chinese extraction and, though only in his early thirties, already has an impressive international record. Both work in the realm of photography, broadly defined. (Jeff Wall had a major exhibition at the Vancouver Art Gallery earlier this year, and Ken Lum will have one there later this year). Much of Jeff Wall's concern focuses upon Vancouver, and this inevitably means the Asian population in part. Among other things, he has movingly commented upon racial prejudice in images which are dense with social and economic references. Ken Lum shares some of this, but at present he focuses upon individuals and how they are shaped and named by their society. It would be false to characterize Jeff Wall as an ousider looking at Asian experience, as it would be to characterize Ken Lum as a Chinese looking at western experience. Instead, both are looking in their own ways at the place in which they — and we — live, because they both share it. It is this multi-cultural experience, and the thoughts and observations about it, that signals the impact of Asia — not its art as such but the people who make and see it — upon Canada and the West, and vice-versa, in the twentieth century.

ACADEMY III / ACADÉMIE III

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PRESIDENTIAL ADDRESS: NORMAL AND MALIGNANT HEMOPOIESIS; MODELS OF GROWTH, DIFFERENTIATION AND CANCER

E.A. McCULLOCH, O.C., F.R.S.C.*

Normal and malignant hemopoiesis; models of growth, differentiation and cancer†

"and gives to airy nothing a local habitation and a name"
Shakespeare, *A Midsummer Night's Dream*
Act V Scene 1

Recent presidents of the Academy of Science have addressed their colleagues about science, usually their own research. This practice is symbolic of a conviction that science itself is paramount, not its organization, leadership, funding or politics, interesting though these may be. I follow the example of my predecessors; in doing so I hope to convince you that much progress has been made in cancer research; that concepts or processes that traditionally are described in abstract terms — growth, differentiation, malignancy — increasingly can be specified in physical or chemical terms and related to defined genes or genetic loci.

My examples are taken from normal blood formation and its malignant counterpart, leukemia. I cannot avoid introductory words about each.

THE FORMATION OF THE CELLS OF THE BLOOD (HEMOPOIESIS)

It is not surprising that as a species, we have often attributed religious or mystical qualities to blood, for blood is essential to life. Everyone knows that the familiar phrase "bleed to death" is a literally accurate description of a possible event. It is not so well known that the cells that circulate in the blood all have finite life spans; they must be replaced continuously; failure of this replacement process is just as fatal as bleeding, although somewhat slower. Victims of high-dose radiation take about a month to die; they succumb to infection, anemia and hemorrhage, because their white blood cells, platelets and red cells have not been replaced.

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† Presidential address, Academy of Science, University of Victoria, 6 June 1990.

Replacement of the mature cells that circulate is the function of a very small population of marrow cells, called stem cells. The existence of such cells had been postulated on theoretical grounds for years[1]; they remained enigmatic[2] until J.E. Till and I reported an assay for cells capable of forming cellular splenic nodules following injection of marrow into heavily irradiated mice[3]. Each spleen colony was soon shown to contain at least three different lineages of blood cells, all derived from a single progenitor[4]. Thus the nodules were cellular populations each derived from a single cell; they conformed to the definition of cellular clones. Their cell of origin was given the operation name colony-forming unit or CFU, now usually with the suffix S (CFU-S) to denote the anatomical site in the spleen. The method was quantitative; by counting spleen colonies it became possible to estimate many of the biophysical properties of their cells of origin, including density, sedimentation velocity and radiosensitivity. Examination of the cellular composition of spleen colonies provided a minimal estimate of the biological capacities of CFU-S; these included extensive growth potential (greater than 20 doublings). The presence within splenic clones of developing and mature white cells, red cells and platelets was evidence of differentiation. New CFU-S were demonstrated in colonies by dissecting them free from splenic tissue, and retransplanting the cells into secondary irradiated recipients. Therefore, during colony-formation, each CFU-S gives rise to progeny like itself (self-renewal). These biological properties provided a definition of CFU-S that coincided with the theoretical expectations for the stem cells of the blood: that is, great proliferative capacity, including self-renewal; and the ability to give rise to progeny with different properties; these progeny can be described as lineages consisting of a series of transitions between parent and daughter cells, accompanied by the acquisition of the apparatus needed for specific function and associated with loss of capacity for growth[5]. Thus, each of the different functional cells of the blood is the end result of a program that began when a stem cell initiated differentiation rather than self-renewal. Understanding regulation of stem cells continues to prove both controversial and difficult. Although in physical properties CFU-S are only moderately heterogeneous, when the cellular composition of spleen colonies was analysed, great clone-to-clone variation was found. For example, when individual spleen colonies were assayed for their content of CFU-S, most were found to contain very few if any new stem cells, while a minority were enriched for this primitive population[6]. The generation of great heterogeneity during clonal expansion occurring over 10-12 days was not easy to reconcile with any precise regulatory mechanism governing the balance between stem cell renewal and differentiation. Rather a stochastic mechanism was proposed: self-renewal was considered to be a 'birth' event, while differentiation, which reduces capacity for growth, was a contrasting 'death' event. 'Birth' and 'death' were considered to occur at random during clonal expansion, governed only by definite probabilities[7]. Such a random process has been shown to generate the distribution observed experimentally. While most readily agreed, and continue to accept, that the balance between renewal and differentiation is a major target for regulatory

mechanisms, many found the stochastic principle uncongenial as a regulatory basis for such an essential basis for such an essential function as blood formation.

Physiological genetics provided a different approach to stem cell regulation. Mice were available with mutations affecting hemopoiesis; the role of the counterparts of mutated genes might be deduced by analysing the phenotypes of the mutant animals. Mutations at the W (at linkage group XVII) or S1 (at linkage group IV) loci proved particularly illuminating. Mice of genotypes W/W^v and $S1/S1^d$ are superficially similar; they have white coats (but black eyes), anemia and increased sensitivity to the lethal effects of ionizing radiation. In each, the hematological defect can be traced to stem cells; but here the similarity ends. Mice of genotype W/W^v have defective stem cells, unable to form macroscopic spleen colonies[8]. In mice of genotype $S1/S1^d$ the stem cells are normal; the lesion affects the capacity of marrow and spleen stromal cells to support hemopoietic cell growth and differentiation[9]. Indeed, physiological complementation is possible, since the anemia of W/W^v mice can be cured by transplantation with marrow from $S1/S1^d$ donors. These data provided convincing evidence for genetically-based regulation, pleasing to those who prefer to see defined controls, as opposed to stochastic mechanisms. Moreover, intracellular and external mechanisms were identified by the genetic approach; both are needed since stem cells must be able to respond successfully to external factors.

Concepts of regulation were enlarged further with the discovery that the precursors of blood cells could grow and differentiate in cell culture. Independently and at about the same time, Bradley and Metcalf in Australia[10] and Pluznik and Sachs in Israel[11] described the requirements for such growth; these included a semi-solid support medium, so that clonal populations remained localized as colonies in culture dishes, and the presence in the cultures of a source of growth stimulator; the latter requirement could be met either by plating the blood cells over "feeder" cells or by adding media in which such cells had been cultivated (conditioned media). Many workers attacked the problem of the identity of the bioactive species in conditioned media, often using sophisticated purification procedures coupled with sensitive biological assays for activity. Numerous growth factors were described and named[12]. During the same period molecules acting on the cells responding to infection of injury were being purified; these were first called cytokines, and more recently, interleukins[13]; their number and complexity equalled that of the growth factors. Molecular cloning has introduced some order into this chaotic field. The genes bearing the information specifying the structures of many growth factors and interleukins has been isolated and can be propagated in suitable hosts. The protein products of these genes can be produced artificially, with great purity and in quantity[14]; the nature of both the gene and protein could be specified precisely. It soon became apparent that the same factor had been described under different names; that factors often worked collaboratively on the same target or indirectly by stimulating adjoining cells to release yet

other factors. Further, the same factor was found to stimulate not only different blood precursors but even cells from outside the blood-forming system.

A link has been discovered between the genetically determined regulatory mechanisms at the W locus and growth factors; although factors and interleukins act on many different target cells, they always behave in a very similar way. Each factor binds to a receptor in the outer membrane of the target cell. Following binding, a series of biochemical events occurs that together constitute a signal that initiates events in the nucleus leading to cell division[15, 16]. The receptors have many common structural features including a region (domain) for binding at the exterior of the membrane, a transmembrane portion that serves as an anchor, and an internal domain with protein kinase activity. In some instances, the internal domain is a tyrosine kinase, an enzymatic activity often found in the protein products of genes that are known to cause cancer (oncogenes)[17]. Oncogenes have counterparts in normal cells, called proto-oncogenes; one such, c-kit has been shown to have structural properties very similar to those of growth factor receptors, including a tyrosine kinase internal domain. Recent genetic experiments have shown that c-kit maps within the W locus[18,19]; it has been postulated that its product acts as a receptor for an as yet unidentified growth factor that may be the gene product of the S1 locus.

Receptors anatomically located within the cell provide yet another regulatory mechanism[20,21]. These bind to well known steroids such as cortisone, sex hormones, thyroid hormones, vitamin D_3 and the active component of Vitamin A, retinoic acid. Molecular clones have been obtained for almost all of the intracellular receptors; the general features of their mechanism is known; after binding, the complex moves to the nucleus and there directly affects the expression of various genes by binding to DNA. These multiple signals impinging on hemopoietic stem cells from receptors at the membrane are all genetically-controlled, since they are mediated by the products of specific genes; most of them affect stem cell behaviour, and particularly the balance between self-renewal and differentiation. However the messages they carry are not necessarily consistent; rather it appears that the reproductive machinery of the cell is barraged by information, but, at least in respect to 'birth' and 'death' has only two alternative responses. It is perhaps less surprising then, that the outcomes of 'birth' or 'death' decisions are so well fitted by a stochastic model. Indeed, the multiple genetically-determined messages may serve not to determine the balance between renewal and differentiation but rather to set the probabilities of each event. From this point of view, the stochastic and genetic theories of stem cell regulation may be reconciled.

ACUTE MYELOBLASTIC LEUKEMIA (AML)

The leukemias, the name for cancers arising in blood-forming tissues, are widely disseminated at the time of diagnosis; early diagnosis followed by local control is not a management option. It follows that leukemias provide models

for any cancer that has spread by the blood stream from its site of origin. Leukemia has the additional advantage that the cancer cells circulate in the peripheral blood and reside in marrow, sites from which the cells can be obtained safely and ethically for laboratory study. The studies described here were conducted on one form of leukemia, acute myeloblastic leukemia, commonly abbreviated as AML.

In common with many other blood diseases, AML begins in the normal stem cells of the blood forming tissue[22, 23]; in each patient a leukemic stem cell gives rise to a single abnormal clone that dominates the blood forming tissue. Some cells following normal patterns of maturation can usually be found within AML clones, but the dominant and defining feature is the presence of large numbers of cells lacking evidence of differentiation; these are called blast cells. Normal stem cells either fail to produce progeny or become extinct. Thus the cellular composition of blood and marrow in AML patients may be analysed in the same way as cells from clones in animals or in culture. For example, great variation is seen in the hemopoietic findings among patients; in one study, the cellular distributions of the progenitors of white cells and red cells were found to be very similar to that seen when spleen colonies were compared. The form of the distributions led to the conclusion that the findings in any particular individual did not reflect the disease process, but only stochastic events occurring during clonal expansion[24]. It is necessary to distinguish between features of AML clones that can be ascribed to such stochastic events and others that are expressions of the disease itself. In my laboratory, we have resolved this difficulty by concentrating on blast cells.

The blast cells of most AML patients grow in cell culture. An early conclusion from the results of the cell cultures was that AML blasts are heterogeneous in respect to growth capacity. A minority can be shown to have the stem cell property of self-renewal[25]; these can also start a series of divisions associated with loss of proliferative capacity; often these divisions are accompanied by cellular changes that are analogous to differentiation[26]. Thus, AML blasts behave as a lineage maintained by its own stem cells. It was obvious that the origin of the blast lineage had to be questioned, together with its significance for theories of disease mechanism in leukemia.

A conventional view of blasts in leukemia is that they represent blocks in differentiation[27], perhaps associated with a loss of the normal coupling of self-renewal and the beginning of cell maturation[28]. Observations suggesting that differentiation continues, albeit abnormally, in blast populations did not support the first part of the usual model; examination of blast self-renewal provided evidence that the process was consistent with the stochastic model described earlier, findings that do not support a dissociation between self-renewal and differentiation[25]. We proposed that the blast lineage was the outcome of abnormal gene expression; that, as a consequence, components of the differentiation programs of normal lineage were assembled abnormally[26]. This proposal led to the prediction that gene products would be found on blast cells in unusual associations. Such gene products are often antigens that can be recognized by antibodies; much work has been done in developing reagents

that recognize markers in normal differentiation and distinguish one lineage from another. Particularly, a clear distinction exists between the cells that mount the immune response (lymphocytes) and those that produce red cells, some white cells and platelets (myelopoietic cells). This background made it possible to contrast the conventional blocked differentiation view of leukemia with the abnormal lineage hypothesis. In the former, lineage distinctions would be maintained; each leukemia should consist of cells expressing faithfully markers of differentiation until a block is reached. In the latter, leukemic populations should express simultaneously markers characteristic of different lineages. Much helped by knowing what to look for, we found markers of different lineages on single blast cells; to contrast these observation with those to be expected if differentiation were blocked in leukemia, we coined the term "lineage infidelity" to describe the differentiation processes that led to such doubly marked leukemic cells[29]. The concept and the name were met with the skepticism to be expected for the unconventional. However, others reported similar observations[30, 31, 32, 33]. Further support came from molecular studies. Certain genes in lymphoid cells undergo re-arrangements in order to generate the capacity to recognize a large number of different antigens. Such re-arrangements were found in blast populations considered on widely accepted criteria to be AML[34, 35, 36, 37, 38]. At present, the observation that AML blast cells may express markers of several lineages is no longer in doubt. The explanation remains controversial. Some authors, holding to the blocked differentiation hypothesis, have suggested that expression of genes of various lineages is characteristic of very rare early stem cells; and that this behaviour is retained (frozen) by malignant transformation[39]. Regardless, it is clear that the blasts of AML are a subpopulation within clones derived from pluripotent stem cells; that, in addition to blast cells, these clones contain normally differentiating lineages.

The debate about the nature of AML clones is not only an intellectual exercise. Rather, views about cellular organization are the basis for management strategy. At present, patients with AML are treated with very extensive and toxic regimens of chemotherapeutic drugs, developed over the last two decades by steady escalation of drug dose and number. The results of treatment are sometimes dramatic. Leukemic cells can no longer be detected in blood or bone marrow; normal hemopoiesis resumes; the patient is restored to health; a complete remission has been achieved[40]. Regrettably, the median time to relapse is usually less then one year; only an occasional patient lives long enough to be considered cured of the disease. Nor is there convincing evidence that treatment outcome has been improved. At the Ontario Cancer Institute/Princess Margaret Hospital (OCI/PMH) we have, in the last 12 years, conducted 4 sequential clinical trials, each more intensive than its predecessor[41, 42]. The survival experience of patients entered into these trials has not changed; the survival curves are remarkably reproducible; they are biphasic, with the majority of deaths occurring in the first few months; thereafter the rate of loss of patients is much slower. It is unquestioned that the disease is responsive to treatment; experience before chemotherapy shows that almost

all untreated patients die within the first six months after diagnosis; but the response varies greatly from patient-to-patient and is not strongly correlated with the details of the drug regimen. It is indeed tempting to seek a biological mechanism for remission. Such a search is certain to be guided by a model of AML clones and their interactions with drugs.

The drugs used in the treatment of AML destroy the growth capacity of cells. The most obvious mechanism for remission-induction, therefore, is the elimination of the stem cells that maintain the malignant clone. Firm evidence is available that AML clones can be suppressed and that normal blood formation resumes; it is also evident that remissions can be achieved by the production of normal blood elements from malignant stem cells[43, 44, 23]. If the blocked differentiation model were correct, drugs, in addition to killing cells, might be considered to remove the block and permit differentiation to proceed. Such a mechanism is plausible because, in certain established cell lines, differentiation can be induced by chemicals such as dimethylsulphoxide (DMSO)[45, 46] or vitamins, such as retinoic acid[47], or certain growth factors[28]; but similar responses are rare in freshly explanted cells. The abnormal gene expression model also provides an explanation of remission based on differentiation. If chemotherapy were to eliminate the abnormal blast lineage, while leaving some abnormal stem cells intact, these could continue to produce normally-functional blood cells. Relapse would occur when blast cells were again generated from their pluripotent ancestor. Support for this model is obtained from observations showing that blasts at relapse may belong to the original leukemic clone but be significantly different from the blast population seen when the clone was first recognized[48]. Regardless of the correct model of AML clones, it is evident that new approaches to therapy are needed, since so little progress has been made with present chemotherapy. The observation of differentiation from malignant cells clearly points to the exploitation of regulatory mechanisms as a promising avenue for exploration.

THE CHEMOSENSITIVITY OF SELF-RENEWAL

The balance between self-renewal and differentiation, the probabilities of 'birth' and 'death', are central the growth or decline of cellular clones, normal or malignant. These events are promising targets for regulatory mechanisms or therapeutic interventions. The cell culture methods developed for the study of AML blasts make it possible to obtain semi-quantitative estimates of the 'birth' and 'death' probabilities. Briefly, blast cells can be grown under two different sets of conditions. In one, the cells are immobilized in the viscid material methylcellulose; blast stem cells divide, the progeny remain localized, and after a few days a cell colony can be detected and counted. However, most of the cells within the colony lack growth capacity; conditions in methylcellulose support enough terminal divisions to permit colony-formation, but self-renewal can be detected only rarely. The number of colonies is thus a reflection of the 'death' probability. In the complementary method the blast cells are grown in liquid media. After varying intervals of time, the cells

are harvested, counted and plated in methylcellulose; the number of blast stem cells in the suspension culture can be determined by taking the product of the number cells recovered from the suspension culture and the number of colonies obtained from the plating step. Often blast stem cells increase in such suspension cultures as a result of self-renewing divisions; thus, in contrast with the primary methylcellulose assay, suspension cultures permit self renewal to occur and changes in blast stem cell number in suspension provide an estimate of the 'birth' probability[49].

The proposal that the methylcellulose and suspension assays measure different aspects of stem physiology leads to the prediction that the methods would yield different outcomes to the same stimulus. This was confirmed by constructing drug dose response curves using both assays. Drugs were chosen because they were used clinically in the treatment of AML. They were cytosine arabinoside (ara-C), 5-azacytidine (5-aza) and adriamycin (adria). The first two are lethal to cells because they are incorporated into DNA, the third kills by binding to DNA. For all three drugs, survival of either colony formation (the methylcellulose assay) or clonogenic cell recovery (the suspension assay) declined with increasing drug dose; the relationship between survival and drug dose could usually be fitted adequately with a simple negative exponential curve; for convenience, the curves were described by the drug dose required to reduce survival to 10 per cent (the D10), which is, of course a descriptor of the slope of the curve. When survival curves were obtained in suspension and methylcellulose for adriamycin, the slopes were indistinguishable. But when either of two that were incorporated into DNA were used, differences in the D10 in suspension ($D10_s$) and in methylcellulose ($D10_{mc}$) were easily demonstrated. For ara-C the cells were more sensitive in suspension while in the reverse relationship was found for 5-aza[50, 51].

On this slender scaffold of empirical data a model was proposed. The basic assumption was that the observed differential sensitivity was based on a selection for self-renewal in suspension and for terminal divisions in methylcellulose. Accordingly, we suggested that, in addition to general cytotoxicity, ara-C and 5-aza had some specificity for functions required for self-renewal. For ara-C this specificity was considered to be preferential incorporation into stretches of DNA encoding genetic information required for self-renewal. Increased sensitivity in suspension was then attributed to lethal effects arising from attempts to transcribe or translate this DNA.

Circumstantial evidence in support of the model was sought from the clinical experience; cellular clones expand and are maintained by the self-renewal of their stem cells. It follows that self-renewal is a highly appropriate target for anti-leukemic treatment. It was striking, then, that, over two decades, ara-C was included in almost every effective protocol[52], including the first three used at the OCI/PMH. Further indirect support was obtained by seeking for associations between drug sensitivity in culture and the success of treatment in vivo. Previously we had shown that a measure of self-renewal obtained from replating colonies from methylcellulose was predictor of response but that the ara-C sensitivity of colony-formation had no such power[53]. In contrast,

in both a preliminary series and a more detailed analysis [50, 49], a significant association was found between successful remission induction and sensitivity to ara-C when measured in suspension cultures. We interpreted the findings as support for the view that some AML clones were responsive to chemotherapy because they relied on self-renewal mechanisms that were drug sensitive.

Conventionally, chemotherapy is given as a combination of drugs. In theory, such a tactic exploits multiple sites of drug action and minimizes the emergence of resistant cells. We argued that drugs without some specificity for self-renewal might contribute more toxicity than benefit. Fortunately, at the time ara-C at very high doses was being tested as a treatment for AML resistant to standard regimens or following relapse. We proposed that ara-C at high dose should be used by itself as a primary treatment, arguing that a drug active against blast self-renewal should be used at maximally tolerated dose; no toxicity should be wasted on drugs such as adriamycin that had only general effects on growth. A protocol was prepared and, in spite of its unconventional features, was accepted by the Human Subjects Review Board. When implemented, it yielded a higher incidence of successful complete remissions than its predecessors, although the duration of survival was not improved[42]. This clinical result showed that a single drug could be as effective as a combination; it was also the first example where our laboratory work led directly to a protocol design.

REGULATION OF AML BLAST STEM CELLS

Earlier, regulators of normal hemopoiesis were described that set the balance between self-renewal and differentiation. The concept that self-renewal may be the crucial target for treatment established a priority for similar studies in AML blast stem cells. And, just as the clonal concepts of cellular organization were found to be applicable to both normal and malignant cell populations, so the conceptual framework developed to describe normal regulation was readily adaptable to AML blasts. Examples have been given earlier of the very heterogeneous clones that can develop from quite similar stem cells. Analysis of new clonogenic cells in blast colonies in cultures yields similar asymetrical distributions, of a form that could be generated by 'birth' and 'death' occurring at random during colony-formation. Regulation by receptor-binding also occurs in blast populations. Occasionally blast cells will grow in cultures containing only nutrients; in most instances the same growth factors active on normal hemopoietic cells are required by blast populations. Intracellular receptors for hormones are expressed in blast cells and their binding to steroids or retinoic acid strongly influences blast behaviour.

Finally, the human counterpart of the c-kit oncogene, described earlier as the protein product of the murine W locus, is expressed in all AML blast populations, although not in some continuous AML cell lines[54]. Thus, blast cells are exposed to the same barrage of signals that affect normal cells and

appear to respond by establishing probabilities of self-renewal or differentiation[55].

The two culture methods were used to determine how the binding of regulators to their receptors affected the balance between renewal and differentiation. For growth factors, AML blast cells were grown under optimal conditions in suspension and the cultures divided into two sets; one set was exposed to factors alone or in combination in methylcellulose to determine PE_{mc}; the other set were exposed to the same conditions in suspension, and to obtain the standard "read-out" measures (PEs, clonogenic cell recovery, nucleated cell recovery and generation of adherent cells). These parameters include 'death' related measurements such as PE_{mc} or adherent cell number, and 'birth' related values such as PE_s and clonogenic cell recovery. When plotted appropriately as star diagrams, a graphic technique displaying measurements with different scales[56], a visual representation is obtained of the balance between the two biological forces, and how this balance is altered by changing growth conditions[57]. It was apparent that shifts could be detected readily, although, as for other parameters of AML, there was much patient-to-patient variation.

Cell cultures were used to examine the effects of retinoic acid as an example of a regulator that binds an intracellular receptor. We found, as others have[58], that fresh cells respond in many ways, including both stimulation and inhibition. More consistent data were obtained using cells from 3 continuous lines (OCI/AML1-3) established at the Ontario Cancer Institute.

Cells of these lines express the retinoic acid receptor to differing degrees; the greatest gene expression is seen in OCI/AML3, followed in descending order, by OCI/AML2 and OCI/AML1. With the clonogenic assay, inhibition of colony-formation was seen with all three lines; the order of response to retinoic acid was the same as that for expression of the retinoic acid receptor; that is, the cells with the highest expression were the most sensitive to inhibition of colony-formation by retinoic acid. In the suspension culture assay we found that the major effect of retinoic acid was to reduce the self-renewal of clonogenic blast cells, while leaving intact the capacity of post-deterministic blasts to generate progeny. Thus, for these cells, retinoic acid strikingly inhibited self-renewal, while leaving intact the capacity of the cells to undergo terminal divisions.

REGULATION AND CHEMOTHERAPY

These data made it evident that AML blasts often respond to the same regulatory influences as normal blood-forming cells, although the responses are not usually beneficial, except, perhaps, to the tumor. Research gained an advantage; it became possible to affect experimentally the balance between self-renewal and differentiation and to test the hypothesis that cells undergo divisions leading to self-renewal have different sensitivities to some chemotherapeutic drugs than cells in terminal divisions.

Previous work had shown that the effects of growth factors on blast cells required the continuous presence of the factor. In contrast brief exposure to retinoic acid often led to changes that could be detected after the agent was washed away from the cells. It follows that different experimental protocols were suitable for exploring for interactions between drugs and the two classes of agent. For retinoic acid, cells were exposed for varying times, washed and tested for ara-C sensitivity in suspension culture. In tests of the effects of recombinant growth factors, these were present throughout the period of drug exposure in suspension. For each set of circumstances, the effects of the biologicals on self renewal were determined. The outcomes were not as expected. The model under test contained the postulate that ara-C is particularly effective in killing blast stem cells that are undergoing renewal; for the growth factors, the prediction was confirmed, since population shifted in the direction of self-renewal regularly showed increased ara-C sensitivity[59]. In contrast, although exposure to retinoic acid regularly decreases self-renewal, ara-C was more toxic to treated cultures than to controls. For some populations rapid shifts in sensitivity were seen as a function of time after retinoic acid exposure[60]. These data made it necessary to reconsider the underlying hypothesis. It remained evident that changes in self-renewal probability were associated with altered drug sensitivity; it was no longer clear that the association was strong or mechanistically significant.

Several alternate explanations deserved consideration. Prominent among these came from a model developed by Bruce and his colleagues to explain how chemotherapeutic agents can sometimes be much more toxic for malignant cells than for their normal counterparts[61]. They made use of knowledge of events that occur as cells move from one division to the next, a sequence that is called the cell cycle[62]. Following mitosis there is a time gap (gap 1 or G_1)[63]; then the cells begin making enough new DNA to double their genetic complement. This part of the cycle is called the synthetic or S phase[64]. It is followed by a second gap (G_2) and then by mitosis (M phase)[65]. A further state of the cycle (G_o) was defined for those cells that are not in a state of active proliferation[66]. Bruce and colleagues related the cytotoxic actions of chemotherapeutic agents to the cell cycle parameters. Particularly they noted that some, such as ionizing radiation, were active at cells throughout the cycle or in a resting (G_o) state. Other drugs showed cycle specificity, either acting only during DNA synthesis or requiring proliferation to be lethal. Since normal hemopoietic stem cells are often in G_o while tumor cells are in active cell cycle, drugs with S-phase or cycle specificity are able to destroy tumor cells while sparing normal cells. Although the model was designed to show how drugs can distinguish between normal and tumor cells, many have extended it by postulating that time spent in each phase of the cycle may differ among tumor cells or even within the same cancer.

This theory might explain the changes in ara-C sensitivity observed when leukemic cells are exposed to regulators such as retinoic acid or growth factors, particularly since killing of cells by ara-C is closely correlated with incorporation of the drug into DNA[67]. A test of this mechanism requires measurements

of cell cycle parameters. These are usually determined by measuring by radioautography the incorporation of a precursor of DNA (usually ^{3}HTdR) either into a total cell population or the kinetics of appearance of labelled cells in mitosis following a pulse of ^{3}HTdR. More recently techniques have been developed for obtaining biophysical measurement of cell size and DNA content by examining cells flowing in droplets and excited by lazer light (flow cytometry). These methods, entirely appropriate for the homogeneous populations first used to describe the cycle, are not adequate for crucial minority populations, such as the stem cells in differentiation clones. (3)HTdR and flow cytometry reflect principally the majority population of terminally-dividing or proliferatively inert cells. A method more selective for stem cells is to expose populations to a short pulse high specific activity ^{3}HTdR; those stem cells that incorporate the radioisotope lose capacity for colony formation as a consequence of highly localized irradiation of DNA by the incorporated isotope. Thus percentage kill following exposure to ^{3}HTdR is a measure of the proportion of cells in the S phase.

This technique was suitable for the study of the effects of retinoic acid on ara-C sensitivity since the cells were exposed to retinoic acid, then washed before being tested for ara-C sensitivity. OCI/AML-3 cells were exposed to 20 minute pulses of high specific activity ^{3}HTdR after, 4, 8 and 24 hr exposure to retinoic acid; concurrent measurements showed that their ara-C sensitivity was undergoing marked changes. At each time, cell kill following ^{3}HTdR exposure was 70-80 per cent of controls, and did not vary significantly with time following RA exposure[60]. Under these circumstances changes in ara-C sensitivity could not be attributed to alterations in cell cycle parameters. The same approach could not be used to test a cell cycle explanation of ara-C sensitization by growth factors, since in these experiments, unlike those with retinoic acid, factor and drug were present simultaneously. Other mechanisms affecting response cells to drugs required consideration. Much attention is now given to a cell membrane-associated structure called p-glycoprotein; its function appears to be the discharge of toxins, including some chemotherapeutic drugs from cells. Excess expression of the gene for p-glycoprotein is associated with reduced sensitivity to all the drugs that use this mechanism to leave cells[68,69]. An explanation of changes in ara-C sensitivity following exposure of regulators could not readily be based on effects on p-glycoprotein expression since ara-C does not belong to the group of drugs that use p-glycoprotein. A further possible explanation for changes in drug sensitivity might derive directly from the metabolism of ara-C since the enzymes that mediate its activity might be under regulatory control[70].

A strategy was devised that might provide resolution of these dilemmas; if the action of ara-C on self-renewal depends on incorporation into some regulatory region of DNA, then a different drug might be found with similar effects. If the lethal effects of such a drug depended on making lesions in DNA without incorporation, then it would not be expected to have metabolic requirements for activity similar to those of ara-C; by the same reasoning, the putative drug would not be expected to be specific for the S phase of the cycle.

If an agent were chosen, which, like ara-C, did not use the p-glycoprotein system, mechanisms mediated by this protein could be excluded. Fortunately, the previous work had provided a criterion for selecting an agent for further study; like ara-C, a candidate drug should be more lethal for blast cells when tested in suspension than in methylcellulose.

The drug cis-Diamminedichloroplatinum (II), or cisplatin was found to meet the criteria outlined above. The action of cisplatin resembles that of ara-C only in that both act on DNA. The major mechanism for cisplatin toxicity is binding to DNA rather than incorporation[71]; therefore its effects are unlikely to be cell cycle specific or to share metabolic pathway with ara-C. Nor is cisplatin toxicity affected by p-glycoprotein levels. Finally, more killing of blast cells by cisplatin was seen when the cells were exposed in suspension rather than in methylcellulose. Thus cisplatin passed the crucial test; like ara-C, the culture results indicated some preferential killing for stem cells undergoing self-renewal compared to dividing cells generally. Cisplatin has an advantage over ara-C; since its binding to DNA does not require cell metabolism, cells can be exposed to the drug briefly, washed, and then tested for survival. Using this design, much larger doses of drug were needed to achieve toxicity equivalent to that seen with continuous exposure. Nonetheless, when AML blast cells were exposed to cisplatin for 1 hr and then washed, survival was less when the cells were subsequently tested for growth in suspension compared to colony-formation in methylcellulose. With this background information, cisplatin was compared to ara-C in experiments where survival curves for each drug were measured in the presence of growth factors that altered the balance between self-renewal and differentiation. The response of the pattern of cell killing to changes in the regulatory milieu was the same for each drug; that is, conditions that increasing killing with ara-C also increased killing with cisplatin. There findings made it unlikely that the changes in drug effect in response to growth factors could be explained by changes in drug metabolism or variation in efflux of drug from cells. Rather, the findings are consistent with the proposal that both ara-C and cisplatin act on regions of DNA that carry regulatory messages affecting the balance between self-renewal and differentiation.

The mechanism of cisplatin action was probed further, taking advantages of the ability of the drug to inactive cells after brief exposure. AML blasts were treated with cisplatin at various concentrations for 1 hr, then washed, and tested in suspension in the presence of different growth factors. Changes in patterns of survival were very similar to those observed when the cells were exposed simultaneously to factors and cisplatin. It follows that the changes seen in the lethal effects of the drug were a function of the metabolic conditions in which the damaged DNA was used, since the cisplatin-lesions might be expected to be similar at the time the cells were exposed to factors.

HYPOTHESIS

It would be remembered that these experiments, combining regulatory molecules and chemotherapeutic drugs, were undertaken in the context of an hypothesis that linked success in chemotherapy with some specificity of certain drugs for self-renewal mechanisms. The problem from the data was that sensitization to ara-C by retinoic acid was associated with decreased self-renewal, while, for growth factors, sensitization occurred under conditions that favored self-renewal. An important part of the hypothesis is that, in addition to the many genes required for the cell cycle, there are some genes that are either active or inactive in self-renewing cycles but not during terminal divisions; such putative self-renewal-related genes would then be the targets that provide specificity for certain drugs, a concept that is not unreasonable, since there is convincing evidence that both damage to DNA and its repair are heterogeneous[72]. The difference between the effects of retinoic acid, a regulator acting by binding to an intracellular receptor, compared to growth factors, acting through cell membrane receptors, might be based on the differences in regulatory mechanisms between the two classes. Usually in association with their ligands, intracellular receptors bind to regulatory regions of DNA; these mediate activity or repression of structural genes, perhaps including the putative self-renewal genes. For the cell-membrane associated growth factor receptors, complex signalling events and second messengers are required before cell replication as affected, although finally, binding of proteins to DNA is probably required.

The hypothesis then includes the concept that drug sensitivity is affected not only by changes in the balance between self-renewal and determination but also by the mechanisms through which such changes are affected. In concrete terms, it is proposed that binding the retinoic acid receptor to regulatory elements leads to transcription or repression of genes that are required for self-renewal. The transcription of these genes may also be the final step in a signalling sequence that was initiated at the cell membrane by the binding of one more growth factors to their receptors. The transcription of the proposed self-renewal genes is essential to the completion of cells cycle leading to self-renewal. If the proposed genes are damaged before transcription (for example by exposure to cisplatin) or during transcription (for example by either ara-C or cisplatin) stem cells will not survive.

This hypothesis may be important in two ways. First, if correct, changes in drug sensitivity may be used to monitor the effects of growth regulators on genes for self-renewal; sensitivity to ara-C or cisplatin of transcription of putative self-renewal genes, compared to the cell-cycle associated genes, might also help in the identification and molecular cloning of these important genetic elements. Second, the hypothesis includes a novel mechanism that contributes to the dose-response relationship between chemotherapeutic drugs and their cellular targets. If such a mechanism could be exploited successfully in designing therapy, a practical advance would be achieved.

CONCLUSION

The line from Midsummer Night's Dream speaks of "airy nothing". Many important biological phenomena have traditionally been described in terms that might be considered as "airy nothing". Differentiation for example, simply means "becoming different". A major goal for research is to provide the "local habitation and a name". Differentiation is beginning to be understood in genetic terms; successive gene activations or repressions lead to transcription of DNA and translation of the message into protein. Molecules are identified that can be given precise definition in physical and chemical terms. Three dimensional structures are being determined, so that now, enzymatic reactions can be seen with a realism that is truly astonishing. Computers are able to provide moving pictures of molecules that change shape as they interact.
Much of the advances in understanding leukemia have derived from the revolution in molecular biology. Technology has been developed that allows molecules to be analyzed in great detail; to be prepared in large quantities and with great purity; to be modified at will, in order to probe structural/functional relations; and even to be inserted into the genetic material of animals or cells. This is truly genetic engineering.

The molecular revolution has not occurred in isolation. Simultaneously, we have seen a revolution in information science, based on computers. Mention has already been made of computerized molecular modelling. Perhaps the huge data bases and the capacity to search them is even more important. The human genome project, of course, depends on information technology as much as it requires capacity to determine the sequences of nucleotides in DNA.

The impact of these advances on diseases like leukemia is just beginning to be felt. The growth factors that play such an important role in regulation have been prepared in pure form by recombinant technology. Clinical trials have demonstrated effects in vivo equivalent to the cell culture results. Already erythropoietin, a regulator of red cell formation, has been shown to be very effective in relieving the anemia of kidney failure. Much more can be expected. As the basis for hemopoietic dysregulation is traced to defects in a small number of genes, measurements of these genes or their products can be included in epidemiological studies, so that the respective roles of genetic and environmental factors in causation can be dissected; such insights may identify individuals at high risk and lead to effective prevention. Nor is it now impossible to contemplate gene therapy — perhaps the replacement of one or more mutated key genetic elements.

Providing a "local habitation and a name" does not make science mundane; rather opportunities increase. With opportunities come the challenges of developing new strategies for health care. Increasingly the issues will not be technical but social and ethical.

ENDNOTES

1. Baserga, A., Zavagli, G., Ferrata's stem cells: An historical review on hemocytoblasts and hemohistoblasts. *Blood Cells* 7:537-547, 1981
2. Cronkite, E.P., Enigmas underlying the study of hemopoietic cell proliferation. *Fed. Proc.* 23:649-661, 1964
3. Till, J.E., McCulloch E.A., A direct measurement of the radiation sensitivity of normal mouse bone marrow cells. *Radiation. Res.* 14: 213-222, 1961
4. Becker, A.J., McCulloch, E.A., Till, J.E., Cytological demonstration of the clonal nature of spleen colonies derived from transplanted mouse marrow cells. *Nature* 197:452, 1963
5. Till, J.E., McCulloch, E.A., Hemopoietic stem cell differentiation. *Biochem. Biophys. Acta* 605:431-459, 1980
6. Siminovitch, L., McCulloch, E.A., Till, J.E., The distribution of colony-forming cells among spleen colonies. *J. Cell. Comp. Physiol.* 62:327-336, 1963
7. Till, J.E., McMulloch, E.A., Siminovitch, L., A stochastic model of stem cell proliferation, based on the growth of spleen colony forming cells. *Proc. Natl. Acad. Sci.* (USA) 51:29-36, 1964
8. McCulloch, E.A., Siminovitch, L., Till, J.E., Spleen colony formation in anemic mice of genotype W/W^{v}. *Science* 144:844-846, 1964
9. McCulloch, E.A., Russell, E.S., Siminovitch, L., Till, J.E., Bernstein, S.E., The cellular basis of the genetically determined hemopoietic defect in anemic mice of genotype S1/S1^{d}. *Blood* 26:399-410, 1965
10. Bradley, T.R., Metcalf, D., The growth of mouse bone marrow cells *in vitro*. *Aust. J. Exp. Biol. Med. Sci.* 44:287-299, 1966
11. Pluznik, D.H., Sachs, L., The cloning of normal "mast" cells in tissue culture. *J. Cell Comp. Physiol.* 66:319-324, 1966
12. Metcalf, D., The hemopoietic colony-stimulating factors. Elsvier, Amsterdam, 1984
13. Mizel, S.B., The interleukins. *FASEB J.* 3:2379-2388, 1989
14. Clark, S.C., Kamen, R., The human hematopoietic colony-stimulating factors. *Science* 236:1229-1237, 1987
15. Neer, E.J., Clapham, D.E., Roles of G protein subunits in transmembrane signalling. *Nature* 333:129-134, 1988
16. Berridge, M.J., Irvine, R.F., Inositol phosphates and cell signalling. *Nature* 341:197-205, 1989
17. Sherr, C.J., Colony-Stimulating Factor-1 receptor. *Blood* 75:1-12, 1990
18. Chabot, B., Stephenson, D.A., Chapman, V.W., Besner, P., Bernstein, A., The proto-oncogene c-kit encoding a transmembrane tyrosone kinase receptor maps to the mouse W locus. *Nature* 335:88-89, 1988

19. Geissler, E.N., Ryan, M.A., Housman, D.E., The dominant white-spotting (W) locus of the mouse encodes the c-kit proto-oncogene. *Cell* 55:185-192, 1988

20. Evans, R.M., The steroid and thyroid hormone receptor superfamily. *Science* 240:889-895, 1988

21. Beato, M., Gene regulation by steroid hormones. *Cell* 56:335-344, 1989

22. Fiaklow, P.J., Cell lineages in hematopoietic neoplasia studied with glucose-6-phosphate dehydrogenase cell markers. *J. Cell Physiol.* (suppl. 1). New York: Alan Liss, 1982

23. Fiaklow, P.J., Singer, J.W., Raskind, W.H., Adamson, J.W., Jacobson, R.J., Bernstein, D.I., Dow, L.D., Najfeld, V., Veith, R., Clonal development, stem-cell differentiation and clinical remissions in acute nonlymphocytic leukemia. *N. Engl. J. Med.* 317:468-473, 1987

24. Lan. S., McCulloch, E.A., Till, J.E., Cytodifferentiation in the acute myeloblastic leukemias of man. *J. Natl. Cancer Inst.* 60:265-269, 1978

25. Buick, R.N., Minden, M.D., McCulloch, E.A., Self-renewal in culture of proliferative blast progenitor cells in acute myeloblastic leukemia. *Blood* 54:95-104, 1979

26. McCulloch, E.A., Buick, R.N., Minden, M.D., Izaguirre, C.A., Differentiation programmes underlying cellular heterogeneity in the myeloblastic leukemia of man. In D.W. Golde, M.J. Cline, D. Metcalf, and C.F. Fox (eds), Hemopoietic Cell Differentiation. ICN-UCLA Symposium on Molecular and Cellular Biology. New York: Academic Press, 1978, pp. 317-333

27. Greaves, M.F., "Target" cells, cellular phenotypes, and lineage fidelity in human leukemia. *J. Cell Physiol.* (suppl. 1) 111:113-125, 1982

28. Sachs, L., Control of normal cell differentiation in the phenotypic reversion of malignancy in myeloid leukemia. *Nature* 274:535-539, 1978

29. Smith, L.J., Curtis, J.E., Messner, H.A., Senn, J.S., Furthmayr, H., McCulloch, E.A., Lineage infidelity in acute leukemia. *Blood* 61:1138-1145, 1983

30. Mirro, J., Antoun, G.R., Zipf, T.F., Melvin, S., Stass, S., The E rosette-associated antigen of T cells can be identified on blasts from patients with acute myeloblastic leukemia. *Blood* 65:363-367, 1985

31. Neame, P.B., Soamboonsrup, P., Browman, G., Barr, R.D., Saeed, N., Chan, B.B., Berger, A., Wilso, W.E.C., Walker, I.R., McBride, J.A., Simultaneous sequential expression of lymphoid and myeloid phenotypes in acute leukemia. *Blood* 65:142-148, 1985

32. Lanham, G., Bollum, F.J., Williams, D.L., Stass, S.A., Simultaneous occurrence of terminal deoxynucleotidyl transferase and myeloperoxidase in individual leukemia blasts. *Blood* 64:318-320, 1984

33. Childs, C.C., Hirsch-Ginsberg, C., Walters, R.S., Anderson, B.S., Reuben, J., Trujillo, J.M., Cork, A., Dtass, S.A., Freireich, E.J., Zipf, T.F., Myeloid surface antigen-postive acute lymphoblastic leukemia

(My$^+$ALL): immunophenotypic, ultrastructural, cytogenic, and molecular characteristics. *Leukemia* 3:777-783, 1989

34. Cheng, G.Y.M., Minden, M.D., Toyonaga, B., Mak, T.W., McCulloch, E.A., T-cell receptor and immunoglobulin gene rearrangements in acute myeloblastic leukemia. *J. Exper. Med* 65:894-901, 1986
35. Norton, J.D., Campana, D., Hoffbrand, A.V., Janossy, G., Coustan-Smith, E., Jan, H., Yaxley, J.C., Prentice, H.G., Rearrangement of immunoglobulin and T cell antigen receptor genes in acute myeloblastic leukemia with lymphoid-associated markers. *Leukemia* 1:757-761, 1987
36. Ackland, S.P., Westbrook, C.A., Diaz, M.O., Le Beau, M.M., Rowley, J.D., Evidence favoring lineage fidelity in Acute Nonlymphocytic Leukemia: absence of immunoglobulin gene rearrangements in FAB types M4 and M5. *Blood* 69:87-89, 1987
37. Klinken, S.P., Alexander, W.S., Adams, J.M., Hemopoietic lineage switch: v-raf oncogene converts Emu-transgenic B cells into macrophages. *Cell* 53:857-867, 1988
38. Gerhartz, H.H., Bartram, C.R., Raghavachar, A., Schmetzer, H., Clemm, C., Wilmanns, W., Thiel, E., Spontaneous Epsein-Barr transformed B cell line sharing the identical immunoglobulin gene rearrangement with acute myeloid leukemia. *Blood* 73:684-687, 1989
39. Greaves, M.F., Chan, L.C., Furley, A.J.W., Watt, S.M., Molgaard, H.V., Lineage promiscuity in hemopoietic differentiation and leukemia. *Blood* 67:1-11, 1986
40. Curtis, J.E., Cowan, D.H., Bergsagel, D.E., Hasselback, R., McCulloch, E.A., Acute leukemia in adults: Assessment of remission induction with combination chemotherapy by clinical and cell culture criteria. *Can. Med. Assoc. J.* 113:289-294, 1975
41. Curtis, J.E., Till, J.E., Messner, H.A., Sousan, P., McCulloch, E.A., Comparison of outcomes and prognostic factors for two groups of patients with acute myeloblastic leukemia. *Leuk. Res.* 3:409-416, 1979
42. Curtis, J.E., Messner, H.A., Minden, M.D., Minkin, S., McCulloch, E.A., High dose cytosine arabinoside in the treatment of acute myeloblastic leukemia: Contributions to outcome of clinical and laboratory attributes. *J. Clin. Oncol.* 5:532-543, 1987
43. Fearon, E.R., Burke, P.J., Schiffer, C.A., Zehnbauer, B.A., Vogelstein, B., Differentiation of leukemic cells to polymorphonuclear leukocytes in patients with acute nonlymphocytic leukemia. *New Engl. J. Med.* 315:15-24, 1986
44. Jacobson, R.J., Temple, M.J., Singer, J.W., Powell, J., Fialkow, P.J., A clonal complete remission in a patient with acute myeloblastic leukemia originating in a multipotent stem cell. *New Engl. J. Med.* 310:1513-1517, 1984

45. Friend, C., Scher, W., Holland, J.G., Sato, T., Hgb synthesis in murine virus-induced leukemic cells in vitro: stimulation of erythroid differentiation by DMSO. *Proc. Natl. Acad. Sci.* (USA) 68:378-382, 1971

46. Collins, S.J., Ruscetii, F.W., Gallagher, R.E., Gallo, R.C., Terminal differentiation of human promyelocytic leukemia cells induced by dimethysulphoxide and other polar compounds. *Proc. Natl. Acad. Sci.* (USA) 75:2458-2462, 1978

47. Breitman, T.R., Selonick, S.E., Collins, S.J., Induction of differentiation of the human promyelocytic leukemia cell line (HL-60) by retinoic acid. *Proc. Natl. Acad. Sci.* (USA) 77:2936-2940, 1980

48. Farr, C.J., Saiki, R.K., Erlich, H.A., McCormick, F., Marshall, C.J., Analysis of ras gene mutations in acute myeloid leukemia by polymerase chain reaction and oligonucleotide probes. *Proc. Natl. Acad. Sci.* (USA) 85:1629-1633, 1988

49. McCulloch, E.A., Minden, M.D., Miyauchi, J., Kelleher, C.A., Wang, C., Stem cell renewal and differentiation in acute myeloblastic leukemia. *J. Cell Sci. Suppl.* 10:267-281, 1988

50. Nara, N., Curtis, J.E., Senn, J.S., Tritchler, D.L., McCulloch, E.A., The sensitivity to cytosine arabinoside of the blast progenitors of acute myeloblastic leukemia. *Blood* 67:762-769, 1986

51. Wang, C., McCulloch, E.A., The sensitivity to 5-azacytidine of blast progenitors in acute myeloblastic leukemia. *Blood* 69:553-559, 1987

52. Freireich, J., Arabinosyl Cytosine: a 20-year update. *J. Clin Oncol.* 5:523-524, 1987

53. McCulloch, E.A., Experimental approaches to outcome prediction in acute myeloblastic leukemia. In V. Hofman, M.E. Berens, and G. Martz (eds), Predictive tests for Hematological Malignancies. Recent Results in Cancer Research. Heidelberg: Springer-Verlag, 1984, pp.l 76-92

54. Wang, C., Curtis, J.E., Geissler, N.E., McCulloch, E.A., Minden, M.D., The expression of the proto-oncogene c-kit in the blast cells of acute myeloblastic. *Leukemia* 3:699-702, 1989

55. McCulloch, E.A., Minden, M.D., Curtis, J.E., The influence of growth regulation on treatment strategy for acute myeloblastic leukemia. *Cancer Survey 9*, 1990

56. Chambers, J.M., Cleveland, W.S., Kleiner, B., Tukey, P.A., Graphical Methods for Data Analysis. Boston: Duxbury Press, 1983

57. Miyauchi, J., Kelleher, C.A., Yang, Y.-C., Wong, G.C., Clark, S.C., Minden, M.D., Minkin, S., McCulloch, E.A., The effects of three recombinant growth factors, IL-3, GM-CFS and G-CSF, on the blast cells of acute myeloblastic leukemia maintaining in short term suspension culture. *Blood* 70:657-663, 1987

58. Lawrence, J.H., Conner, K., Kelly, M.A., Haussler, M.R., Wallace, P., Bagby, G.C., Jr., cis-Retinoic acid stimulates the clonal growth of some myeloid leukemia cells in vitro. *Blood* 69:302-307, 1987

59. Miyauchi, J., Kelleher, C.A., Wang, C., Minkin, S., McCulloch, E.A., Growth factors influence the sensitivity of leukemia stem cells to cytosine arabinoside in culture. *Blood* 73:1272-1278, 1989

60. Lishner, M., Curtis, J.E., Minkin, S., McCulloch, E.A., Interaction between retinoic acid and cytosine arabinoside affecting the blast cells of Acute Myeloblastic Leukemia. *Leukemia* 3:784-788, 1989

61. Bruce, W.R., Valeriote, F.A., Normal and malignant stem cells and chemotherapy. In The Proliferation and Spread of Neoplastic Cells. M.D. Anderson Annual Symposium on Fundamental Cancer Research. Baltimore: Williams and Wilkins Co., 1967, pp. 409-420

62. Murray, A.W., Kirschner, M.W., Dominoes and clocks: the union of two views of the cell cycle. *Science* 246:614-621, 1989

63. Pardee, A.B., G_1 events and regulation of the cell cycle. *Science* 246:603-608, 1989

64. Laskey, R.A., Fairman, M.P., Blow, J.J., S phase of the cell cycle. *Science* 246:609-614, 1989

65. McIntoch, J.R., Koonce, M.P., Mitosis. *Science* 246:622-828, 1989

66. Baserga, R., Costlow, M., Rovera, G., Changes in membrane function and chromatin template activity in diploid and transformed cells in culture. *Federation Proceedings* 32:2115-2118, 1973

67. Major, P., Egan, E.M., Beardsley, G., Minden, M., Kufe, D., Lethality of human myeloblasts correlates with incorporation of ara-C into DNA. *Proc. Natl. Acad. Sci.* (USA) 78:3225-3239, 1981

68. Gerlach, J.H., Kartner, N., Bell, D.R., Ling, V., Multidrug resistance. *Cancer Surveys* 5:25-46, 1986

69. Gerlach, J.H., Endicott, J.A., Juranka, P.F., Henderson, G., Sarangi, F., Deuchars, K.L., Ling, V., Homology between p-glycoprotein and a bacterial haemolysin transport protein suggests a model for multidrug resistance. *Nature* 324:485-489, 1986

70. Chabner, B.A., Cytosine Arabinoside. In B.A. Chabner (ed.), Pharmacological Principle of Cancer Treatment. Philadelphia: W.B. Saunders, 1982, pp. 387-401

71. Pinto, A.N., Lippard, S.J., Binding of the anttumor drug cis-Diamminedichloroplatinum(II) (cisplatin) to DNA. *Biochimica et Biophysica Acta.* 780:167-180, 1985

72. Bohr, V.A., Phillips, D.H., Hanawalt, P.C., Heterogeneous DNA damage and repair in the mammalian genome. *Cancer Research* 47:6426-6436, 1987

ACADEMY III / ACADÉMIE III

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SYMPOSIUM:
MARINE RESOURCES OF
THE NORTH PACIFIC OCEAN

EDWARD M. DONALDSON, F.R.S.C.*

Introduction†

The proposal for an Academy of Science Symposium on the Marine Resources of the North Pacific was initially submitted to the Animal Biology Section of the Academy at the 1988 RSC Annual Meeting in Windsor. The Symposium was conceived as a wide ranging series of presentations of broad appeal that would harmonize with the overall Pacific Rim theme of the 1990 RSC Annual Meeting to be held in Victoria. Specifically, the Symposium was designed to span, in a single day, the history, current status, and future of the North Pacific Ocean and its living and inanimate marine resources. The day began with a discussion of the origin and development of the Pacific Ocean through the investigation of plate tectonics. This was followed by a presentation of archeological evidence for the non-exploitive use of marine resources by the indigenous peoples of the Northeastern Pacific. The Symposium continued with an assessment of current oceanographic conditions, and talks which delineated the scope and extent of today's marine resource including the following: an evaluation of the status of the wild fishery; the current role and future development of aquaculture; the mineral resource and its potential for development. The Symposium then turned to concerns over the extent and nature of pollution, particularly in coastal waters and an assessment of the global warming phenomenon and projections of future trends in oceanographic and atmospheric conditions. The meeting closed with a presentation on the future cooperative investigation and international management of the Marine Resources of the North Pacific. All but one of the papers presented during the Symposium are presented here in the *Transactions*.

I thank several local members of the RSC who provided advice and assistance during the initial planning of this Symposium including Drs. W.S. Hoar, P. Hochachka, J.A. Laponce, P.A. Larkin, P.H. LeBlond, C.C. Lindsey, G.O. Mackie, L. Margolis, D.J. Randall, and R.W. Stewart.

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† Text prepared to preceed the papers presented at the symposium, "Marine Resources of the North Pacific", University of Victoria, 6 June 1990.

I particularly wish to thank Dr. Christopher R. Barnes and Dr. Timothy R. Parsons for their indispensible assistance in the organization of the Symposium. Financial assistance for the Symposium provided by the Department of Fisheries and Oceans and by the Donner Canadian Foundation facilitated participation by speakers from both Canada and the United States and is gratefully acknowledged.

TANYA ATWATER*

Tectonics of the Northeast Pacific†

The northeast Pacific and its continental rim are presently a region of varied tectonic activity, much of which we interpret using the theory of plate tectonics. Many of the volcanoes, earthquakes, and various land deformations are the direct result of the interactions among the lithospheric plates here. Furthermore, the rocks of the region reveal a tectonic history that was exceptionally varied and interesting, reflecting the fact that the plate configuration has changed dramatically over time. In this article I shall describe a few of the highlights of this interesting area. For more depth, I refer the reader to the *Geology of North America*, Volume N, The Eastern Pacific Ocean and Hawaii, which presents a comprehensive review of our geological knowledge of this region.

NEOTECTONICS

The present day plate tectonic configuration of the northeast Pacific region (Fig. 1) is dominated by the huge Pacific and North American plates. A few oceanic plates lie between these giants. They include the Rivera plate (R on Fig. 1) and a number of remnants of the ancient Farallon plate: the Cocos plate (C) and the Juan de Fuca (F), Winona (W), Explorer (E) and South Gorda (G) plates. Some continental fragments are caught up within the boundary zones and are moving somewhat independently of the larger plates: the Yakutat (Y) block in southeast Alaska and the Humboldt and the California (C) plates in the San Andreas system. Also, there are some segments of the Pacific-North America boundary where the deformation region is broad and pervasive, with significant deformation distributed over a number of adjacent faults. In these regions, the rigid plate description of the earth's surface is simply inadequate. Southwestern California and the Basin and Range region of southwestern United States (B&R) and central Alaska are examples of such regions.

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† Presented at the symposium, "Marine Resources of the North Pacific", University of Victoria, 6 June 1990.

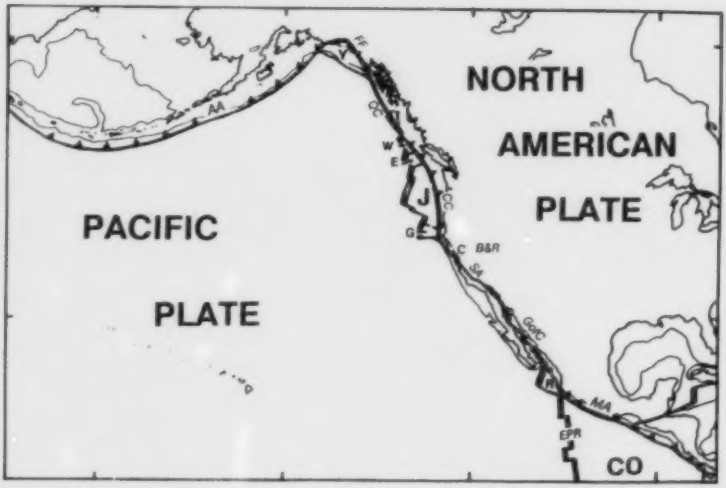

Figure 1. Plates and plate boundaries of the northeast Pacific region, after Atwater (1989). The area is dominated by the Pacific and North American plates. Smaller oceanic plates include the Cocos (CO), Rivera (R), Juan de Fuca (J), South Gorda (G), Explorer (E), and Winona (W) plates. Continental fragments that have been postulated to be small plates include the Yakutat (Y), California (C), and Humboldt plates. Plate boundaries or zones of deformation include the East Pacific Rise (EPR), Gulf of California (GofC), Basin and Range province (B&R), San Andreas fault (SA), Queen Charlotte fault (QC) and Fairweather fault (FF). Spreading centres between the Pacific plate and adjacent small plates are named for the latter.

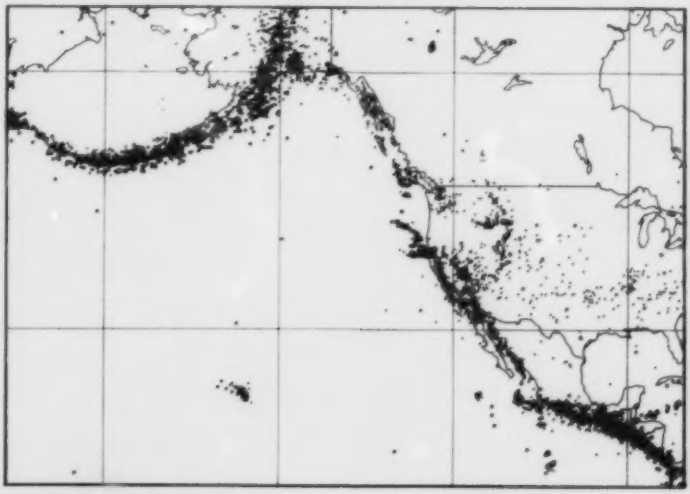

Figure 2. Seismicity of the northeast Pacific, 1977-1986, after Goter (1987). Dots show epicentres of all recorded earthquakes, thinned where a great many overlap. Large symbols mark larger earthquakes.

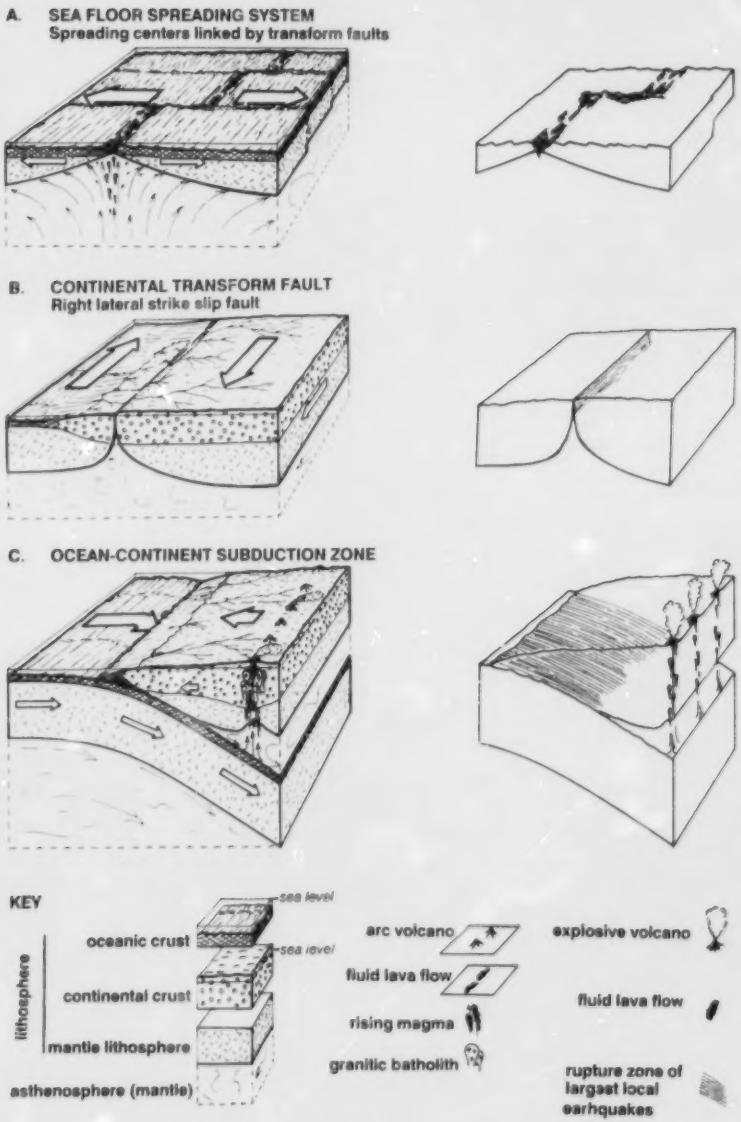

Figure 3. Schematic block diagrams of some plate boundary types found in the northeast Pacific. Left: Typical features for each plate boundary situation. Arrows show relative plate motions. Note that the lithospheric plates include the crust (continental or oceanic) and the cool upper part of the mantle. Right: Tectonic hazards caused by the interactions of lithospheric plates, including typical earthquake rupture zones and active volcanics for each plate boundary type.

The boundaries (or boundary zones) separating plates are the sites of most of the earth's tectonic activity, including earthquakes (Fig. 2), volcanoes, and deformations of the land. Plate boundaries can take various forms, depending upon the relative motion between the adjacent plates (divergent, convergent, or parallel) and the type of crust imbedded in the plate (oceanic or continental). Block diagrams of three of these active plate boundary types and their typical characteristics and hazards are presented in Figure 3. The northeast Pacific region includes good examples of these plate boundary types, as will be described in the next sections.

Seafloor Spreading Systems

When two lithospheric plates diverge, partially molten rock wells up from the mantle to fill the gap, forming new oceanic lithosphere. This process, called seafloor spreading, has been responsible for the formation of all the deep ocean floors of the world. Individual spreading centres tend to be aligned perpendicular to the direction of spreading. However, the overall trend of the rifting plate boundary is rarely in this exact perpendicular direction so that the spreading systems usually consist of spreading segments (perpendicular to the direction of relative plate motion) linked by fault segments called transform faults (parallel to the direction), as shown in Figure 3A.

The oceanic spreading systems of the northeast Pacific include the fast spreading East Pacific Rise (EPR on Figure 1), the intermediate rate Juan de Fuca and Rivera spreading systems, and the continent-dominated Gulf of California seafloor spreading system (GofC). They have been extensively studied and include excellent examples of numerous seafloor spreading phenomena. For example, they demonstrate very clearly the rate-dependent variations in seafloor topography now known over the world (Fig. 4). The

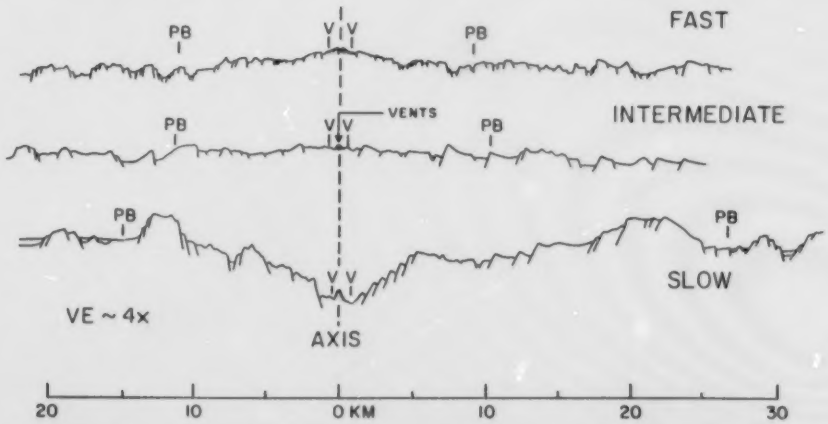

Figure 4. Typical topographic cross sections for open-ocean seafloor spreading centres with slow (15-40 mm/yr whole spreading rate), intermediate (50-80 mm/yr), and fast (90-160 mm/yr) spreading rates (modified after MacDonald 1989).

South Gorda ridge, at 20-30 mm/yr whole spreading rate, shows the mountainous topography and very deep central rift valley typical for slow spreading centres (the mid Atlantic rift valley is another well known example). This central rift is believed to be dynamically held down, reflecting the difficulty encountered by intruding magmas trying to rise in this relatively cold environment (Sleep and Rosendahl 1979). The intermediate rate (50-60 mm/yr) Juan de Fuca and Rivera ridges have smoother topography with small, perched, rift valleys, while the fast spreading East Pacific Rise (110 mm/yr) has a very smooth, gentle high at the centre. It is supposed that magmas rise with little resistence in this hot environment, so that the East Pacific Rise profile represents the natural shape of spreading lithosphere in floating equilibrium (Sclater *et al* 1971). The centre stands high because of the lesser density of the new hot materials beneath the centre (Sleep and Rosendahl 1979, Macdonald 1989).

The Gulf of California typifies another important situation — seafloor spreading dominated by adjacent continents (Lonsdale 1989). The Gulf is actually an extension-dominated continuation of the San Andreas plate boundary, consisting of a number of short northeast trending spreading segments connected by northwest trending transform faults, parallel to the San Andreas fault (Fig. 1). These young spreading centres form oceanic-depth basins surrounded by high-standing continental crust and, thus, are inundated by continental sediments of various thicknesses. They supply a modern analogue for the oceanic basement which lies at the foot of the continental margins in the Atlantic and Indian Oceans, the parts that were formed during the early opening stages of those oceans.

The aspect of the seafloor spreading centres that has generated the most excitement in recent years is the discovery and exploration of numerous hydrothermal vents with their mineral deposits and exotic animals. All of the Pacific spreading centres appear to have some form of active hydrothermal venting and the East Pacific Rise and Explorer Ridge contain some of the most spectacular known examples of these features (Haymon 1989, Barrett and Fox 1988, and numerous other articles in the September 1988 issue of *Canadian Mineralogist*). The vents include numerous warm springs and clusters of white and black "smokers" jetting hot waters up to 400°C. The minerals being deposited around these vents are exceptionally rich in copper, zinc and other metals and appear to be modern analogues for ancient massive sulfide deposits that have been mined since the Bronze Age in Cyprus and Oman. The vent field on the southern Explorer ridge contains gigantic pillars and mounds of these hydrothermal deposits, up to 200 m in diameter and 25 m high (Rona 1988).

The Gulf of California includes another type of vent deposit, resulting from the interaction of hydrothermal waters with young sediments (Peter and Scott 1988, Lonsdale 1989). In addition to the usual minerals, these vent waters include entrained globules of petroleum-like hydrocarbons, formed during the heating of the organic components in the sediments. Carbon-14 dates indicate that they were formed in less than 5000 years (Didyk and Simoneit 1989) as

opposed to the many millions of years usually assumed for petroleum formation. All the vent regions support rich oases of life, including many exotic animals not found anywhere else on earth. Rather than solar energy, these communities live on the chemical energy of the vent water and, rather than plants, they have sulfur-oxidizing bacteria at the base of their food chains.

Continental Transform Faults

The Pacific-North America plate boundary includes two segments along which the relative plate motion direction is nearly parallel to the coastline. These are occupied by continental transform faults, the San Andreas and the Queen Charlotte-Fairweather fault zones (SA, QC, and FF on Figure 1). Both of these active fault systems are dominated by right lateral strike-slip motion. [An observer looking across a right lateral strike-slip fault sees the other side move parallel to the fault, horizontally to the right (Fig. 3B)]. Otherwise, they have little in common.

The San Andreas is a very complicated system. Deformation along the San Andreas fault itself takes up the majority, but not all of the Pacific-North America relative plate motion. Creep and geodetic measurements in central California suggest that about 70 per cent of the motion (35 mm/yr of the predicted 48 mm/yr) occurs along the main strand (DeMets *et al* 1990). The remainder is broadly distributed over a number of secondary faults, folds, and basins both in coastal California (Fig. 5) and as far east as Nevada and Arizona. In a broader view, we might consider the California and Humboldt plates (C and H on Figure 5) as fragments caught in a wide, soft, plate boundary zone. The distribution of seismicity on Figure 2 reinforces this concept, showing that small earthquakes are scattered over a broad region, H and especially C being relatively aseismic.

Compared to that in the San Andreas system, active deformation along the Queen Charlotte fault system is very tidy. The seismicity map (Fig. 2) shows activity to be highly concentrated along the rim of the continent, where bathymetric surveys delineate a very sharp trough near the edge of the continental shelf (Riddihough and Hyndman 1989). At its northern end the Queen Charlotte fault splays into two branches, including the Fairweather fault and outlining a terrane known as the Yakutat block (Y on Figure 1). The Yakutat block is postulated to be the latest of a number of far travelled terranes that have been accreted to the rim of Alaska (Stevenson *et al* 1983), as will be discussed below.

The causes for the striking differences in tectonic style between the San Andreas and Queen Charlotte plate boundaries are not entirely clear. The most obvious difference in the configurations concerns the relationship of the Pacific-North America motion vector to the continental margin trends (DeMets *et al* 1990, Stock and Molnar 1988). The plate motion vector in the San Andreas region is and has been consistently 5-30° counter-clockwise of the continental margin trend, so that this plate boundary has consistently included a component of extension. This extension is presently taken up by the spreading centres in the Gulf of California and it is the likely explanation

for the general, late Cenozoic, geologic fragmentation and the formation of numerous (oil bearing) basins in coastal California. In the Queen Charlotte region, the plate motion vector is about 5-20° clockwise of the continental margin trend so that this boundary is slightly compressional. Earthquakes and other geological data appear to show that this compression is being taken up by slow subduction beneath the continental rim (Yorath and Hyndman 1983, Riddihough and Hyndman 1989), perhaps helping to concentrate the strike-slip motion at the rim as well.

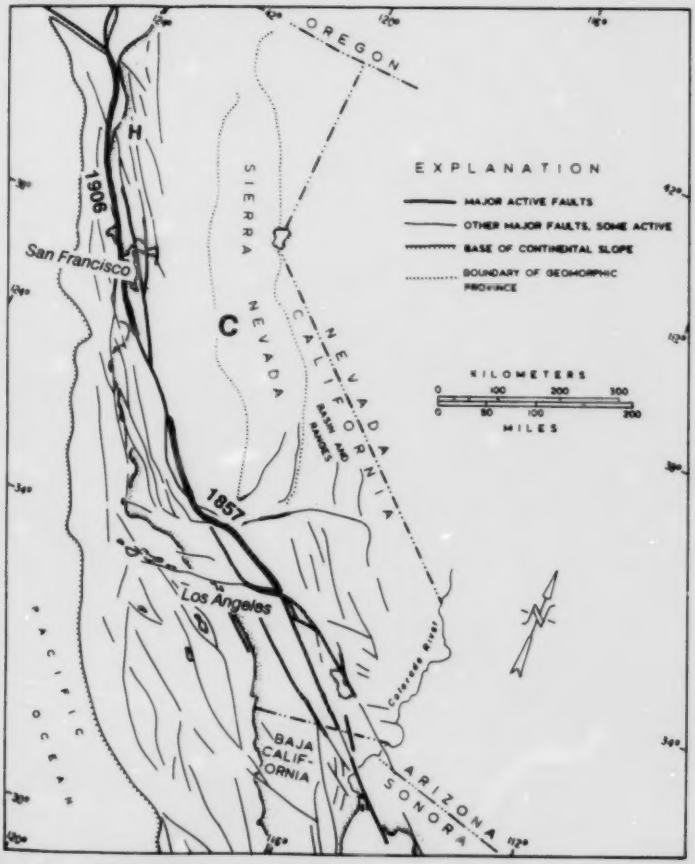

Figure 5. Young faults in the Pacific-North America plate boundary zone of California. Dated heavy lines show ruptures during the 1906 and 1857 earthquakes on the San Andreas fault. Other segments break in smaller earthquakes or creep events. The San Andreas system includes all faults near the coast and in the Gulf of California. Faults farther inland also show substantial components of northwestward, right lateral displacement. The Humboldt plate (H) and, to some extent, the California plate (C) move with velocities intermediate between those of the Pacific and North American plates (modified after Crowell 1985).

Probably the most important aspect of the continental transform faults is their potential for breaking in large earthquakes. In this respect, both the San Andreas and Queen Charlotte faults appear to be segmented, with some of the segments so tightly locked that they only slip during large earthquakes (Figs. 5 and 6). It appears that earthquakes on these segments may have characteristic recurrence intervals (Sykes and Quittmeyer 1981). For example, dated disruptions of river deposits that cross the Palmdale segment of the San Andreas fault suggest a recurrence interval of about 130 years (Sieh *et al* 1989). This 400 km long section last slipped in a magnitude 7.8 event in 1857 (with 10 metres of offset!), so that simple arithmetic suggests that it is due to rupture again soon. It borders the Los Angeles area on the north and northeast (marked **1857** on Figure 5), so the seeming imminence of another large event is a cause for considerable concern. Unfortunately, the known sequence of breaks appears to be quite irregular, interseismic intervals probably ranging from 50 to 200 years, so that this forecast is not very precise. The recurrence pattern for the segment of the San Andreas that devastated San Francisco in 1906 has not been documented but the interval is believed to be significantly greater than 100 years. On the other hand, Ellsworth *et al* (1981) note that earthquake regions tend to be quiescent for a period following a great earthquake and then to have increasing activity leading up to the next large break. They note that the 1906 segment seems to have entered the active stage again since the 1950s, so that increasing seismicity is to be expected in the relatively near future. Furthermore, all the faults in the broader San Andreas system have seismic potential and though their largest earthquakes are commonly smaller than those on the master fault, they still cause extensive damage when they occur in populated regions.

The Queen Charlotte-Fairweather fault system is less threatening both because of its remote, underwater position and because of the sparse human populations in its vicinity. These same characteristics, of course, also make it much less well understood. A magnitude 7.6 event in 1972, relieved the accumulated stress on a 300 kilometre segment near Juneau (Fig. 6) and filled half of a "seismic gap" that had been noted by Sykes (1971) along that part of the plate boundary. The only regions along this boundary that are considered likely to have a large earthquake in the near future are labelled "gap" on Figure 6 (Sykes *et al* 1985).

Subduction Zones

When two lithospheric plates converge and at least one of them is an oceanic plate, a subduction zone is formed. The oceanic plate dives beneath the other, descending into the mantle. Subduction zones in the northeast Pacific include the Aleutian trench and oceanic island arc, the Alaskan trench and continental volcanic arc, the enigmatic Cascadia zone, and the mid-America trench and continental volcanic arc in Mexico. (I will not discuss the latter here). The Alaskan-Aleutian zone displays all the tectonic manifestations of a typical subduction zone (Fig. 3C) including the most explosive type of volcanoes, the largest magnitude earthquakes and significant elevation shifts. The Cascadia

zone shares most of these characteristics but it is anomalous with respect to earthquakes, as described below.

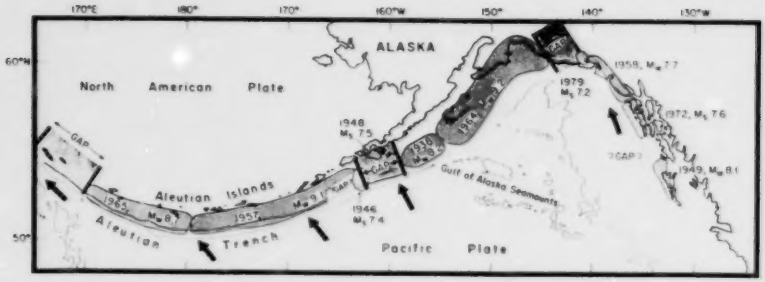

Figure 6. Rupture zones of great earthquakes along the Alaskan-Aleutian subduction zone and Queen Charlotte-Fairweather fault system. Regions marked "GAP" are considered likely candidates for the next large earthquke (from Sykes *et al.* 1985).

Subduction-related Volcanism

Typically, suduction zones are marked by a line of explosive volcanoes, the "volcanic arc", on the overriding plate. This particular style of volcanism tends to build steep volcanic peaks. They are often awe-inspiring and beautiful, hence the many travel posters of Mts. Fuji, Etna, Vesuvius, Popocatepetl, etc., but when they are active they can be extremely dangerous and disruptive (Daniels *et al* 1982). Their eruptions include gigantic explosions such as those that blew away the island of Santorini about 1450 B.C. and blew off the tops of Mt. St. Helens and ancient Mt. Mazama (forming Crater Lake, Oregon). They include hot gas-ash flows (nuee ardente) that burn, smother and bury everyting in their paths. Such flows from Mt. Vesuvius destroyed and buried ancient Pompei.

At any subduction zone, the volcanic arc occurs on the overriding plate over the linear region where the descending slab of lithosphere has reached a depth of 70-150 km. The volcanoes are clearly related to the downgoing slab and early models assumed that the top of the slab simply melted when it penetrated into the asthenosphere beneath the overriding lithosphere. This idea is supported by the fact that the arc magmas tend to be particularly rich in water vapour and other volatiles. (When the pressure is removed during an eruption, these gasses come out of solution with explosive results). The downgoing oceanic lithosphere is naturally water-rich, since it has been stewing in seawater for millennia, so most models associate the production of molten magma with the release of this water at depth. However, other geochemical data from the lavas show that there is also a strong influence from the overriding plate. Perhaps materials are being melted all along the path as the magmas ascend from the slab to the volcanoes (Gill 1981).

Both the Alaskan-Aleutian zone and the Cascadia zone have lines of active arc volcanoes and they cause both awe and anguish. The explosive formation of Crater Lake, in 4600 B.C. laid down a thick layer of ash over the entire northwestern United States and southwestern Canada and ash eruptions wreaked havoc upon the early settlements of coastal Alaska. In recent times, the relatively moderate explosion of Mt. St. Helens, Washington, and the ash eruptions there and at various Alaskan volcanoes have caused significant disruptions of human activities.

Subduction-related Earthquakes and Ground Deformations

The second largest earthquake ever recorded, Magnitude 9.2, occurred in southwest Alaska on Good Friday, 27 March, 1964[1]. Whole sections of Anchorage and Valdez were destroyed by the shaking and by the liquefaction and slippage that occurred in the underlying soils. Tsunami waves were set in motion that destroyed the harbors at Anchorage, Seward and Valdez, carrying boats far inland, and wreaking havoc in coastal communities all around the north Pacific rim (Walker *et al* 1982).

Large subduction zone earthquakes occur when a major segment of the surface between the overriding and subducting plates ruptures all at once. The contact surface between the plates in this situation is very large (Fig. 3C), so the resulting earthquakes are also very large. It is estimated that during the Good Friday earthquake a 130,000 square kilometre patch of the underriding Pacific plate broke loose from the overriding rim of the North American plate and was offset, down-dip, about 12 metres (Algermissan *et al* 1969). In the course of time, the plate motions will cause every portion of the subduction surface to rupture. The rupture surface that broke during the Good Friday earthquake and rupture surfaces from other large earthquakes, as mapped by their aftershocks, are shown on Figure 6 from Sykes *et al* (1985). Notice on Figure 6 that compared to the rupture surfaces broken during the great earthquakes, the two smallest events, magnitudes 7.2, 7.4 and 7.5, have quite small rupture surfaces. Thus, even though there are great numbers of moderate earthquakes along this subduction zone (Fig. 2), they accomplish very little in terms of plate displacements along this subduction zone. Great earthquakes are required.

The typical recurrence interval for these large Alaskan-Aleutian earthquakes is not well known because of the short written history in the region. It is estimated to be 50-100 years along the Aleutians and greater than 100 years at the Good Friday earthquake segment (Sykes *et al* 1985). While this is good news for the near future residents of southwest Alaska, they still must always be prepared for medium size earthquakes.

The seismic situation for residents of the Cascadia region is much less clear. This subduction zone is anomalous in that it has almost no modern seismicity (Fig. 2). There is no doubt that subduction is occurring here. Plate motion calculations predict it, folded and faulted sediments at the continent-ocean interface record the shortening there, and the Cascade volcanoes imply a subducting slab at depth (Duncan and Kulm 1989). Furthermore, studies of

seismic waves traversing the mantle beneath Oregon, Washington, and southern British Columbia show the presence of a high-velocity, low-attenuation region, presumed to be the downgoing slab (Michaelson and Weaver 1986, Harris *et al* 1990).

Two conflicting hypotheses are being entertained to explain the lack of recent seismicity in the Cascadia subduction zone. One (comforting) possibility is that the zone is accomplishing plate displacement by aseismic creep, so that no earthquakes are expected. The other (alarming) possibility is that this plate boundary is particularly stuck so that it has been storing stress for hundreds of years and will have a very large earthquake in the (near?) future. There are several unusual aspects of this subduction zone that may be causing its anomalous behaviour, but unfortunately, each can be interpreted to support either hypothesis. The subduction rate is unusually slow, 30-45 mm/yr (Riddihough 1984), as opposed to 60-120 mm/yr at most subduction zones. It may be that this slower relative motion is more easily accommodated by creep or, alternatively, it may be that there is no creep but because of the slow rate it is taking longer to store enough stress to trigger a large earthquake. Also, the downgoing Juan de Fuca plate is unusually thickly covered by sediments. It may be that these sediments "lubricate" the fault surface, facilitating creep. However, comparisons with other subduction zones suggest that, if anything, the opposite may be true: the presence of extra sediments may homogenize the strength along the interface so that ruptures, once they start to break, can extend unhindered over very large areas in very large earthquakes (Kanamori 1986, Lay and Kanamori 1982). The Pacific plate where it subducts beneath Anchorage, Alaska is also heavily sedimented.

Studies of local elevation changes relative to sea level may supply the needed clue concerning the style of plate subduction along the Cascadia zone. After the Good Friday earthquake in Alaska, it was found that a broad outer-arc region had been suddenly uplifted so that shore lines were displaced upward commonly by 3-4 metres and occasionally by as much as 10 metres, leaving intertidal organisms stranded high and dry. On the landward side of this uplift region, a second broad belt had subsided by as much as 2 metres (Plafker 1965). Similar earthquake related elevation changes have also been observed in Japan, Chile, and elsewhere (West and McCrumb 1988, Atwater *et al* 1988) (Fig. 7).

Along the Cascadia coasts, beach deposits and estuarine sediments contain geologic records of occasional, sudden elevation changes with respect to sea level, reminiscent of the coseismic events observed in Alaska. In northern Oregon and southern Washington sedimentary sequences in numerous river estuaries show sudden burials of marshes by intertidal sediments, sometimes beginning with a sand layer interpreted to be tsunami-related (Atwater 1987). The sudden killing of a "ghost forest" of western red cedars that stands in the tidal marshes of the Copalis river of southern Washington is dated by tree ring analysis at about 1690 (Yamaguchi *et al* 1989). The sediments at Netarts Bay, Oregon, record six abrupt subsidence events (of 1-1.5 metres), each followed by a gradual long-term uplifting, and carbon dating here suggests a recurrence

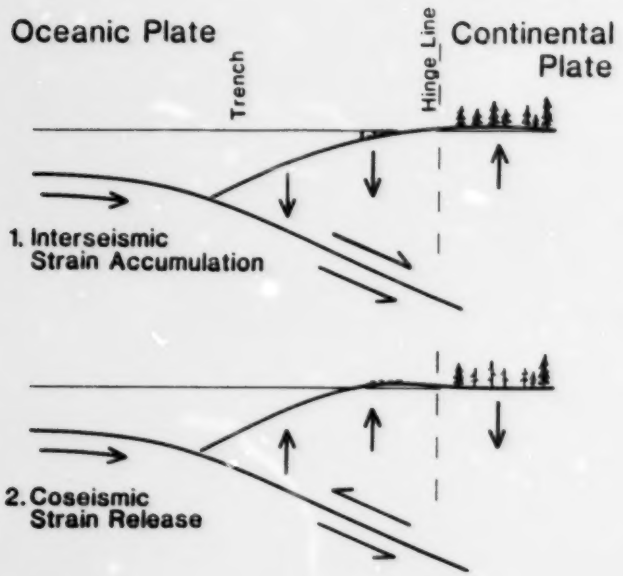

Figure 7. Schematic diagram of vertical coastal tectonics. Overriding plate is gradually deformed as strain accumulates between earthquakes (1). When the plate interface ruptures during an earthquake much of this strain is abruptly released, stranding marine life and inundating terrestrial life (2) (modified after Darienzo and Peterson 1990).

interval of about 300-1000 years, the latest being 300-500 years ago (1690?) (Darienzo and Peterson 1990). Several events along this coast appear to coincide in time, suggesting a subsidence region at least 200 kilometres long. Furthermore, the latest two events may coincide with uplifts of two beach deposits at the mouth of the Mad River, northern California (Carver and Burke 1988), suggesting an earthquake rupture of at least 700 kilometres! Similar studies are being pursued at appropriate sites all along the Cascadia coast, and while the results are still preliminary, we cannot ignore the implication that very large earthquakes might be expected to occur here from time to time (Lisowski and Atwater 1987).

TECTONIC HISTORY

The present plate tectonic configuration of the northeast Pacific, shown in Figure 1, is a relatively recent development. In earlier geologic times, the pacific plate was smaller and other large oceanic plates lay between it and North America. These other plates have since been almost entirely subducted. The Mesozoic-Cenozoic geologic history of North America reflects this

long-term subduction, the arrival and docking of numerous unsubductable terranes, and the subsequent gradual transition from subduction to the present transform-dominated configuration (Atwater 1989).

Magnetic Anomaly Isochrons in the Seafloor and Plate Reconstructions

The primary data set used to make plate reconstructions for past times comes from the magnetic record of sea floor spreading. All of the deep ocean floors were formed by sea floor spreading between diverging plates so that the displacements of the relevent plates can be reconstructed if the ages of the sea floor are known. Luckily, sea floor dates are quite readily obtained from ship-borne magnetic measurements as interpreted via the Vine-Matthews hypothesis (Fig. 8) as follows (see Cox and Hart 1986, for more details). When the sea floor spreads, new basaltic lava is erupted to fill the rift and as this lava cools it becomes permanently magnetized by the earth's magnetic field. The earth's field changes through time, often completely reversing its polarity so that the magnetic north pole then lies near the south geographic pole, and vice-versa. For example, basalts that are presently erupting at the spreading centres are being magnetized toward the north, but those that erupted during the reversed epoch a million years ago were magnetized toward the south. The result of this recording process is that the ocean floors are magnetized in a striped pattern. The timing of the field reversals is quite irregular and the

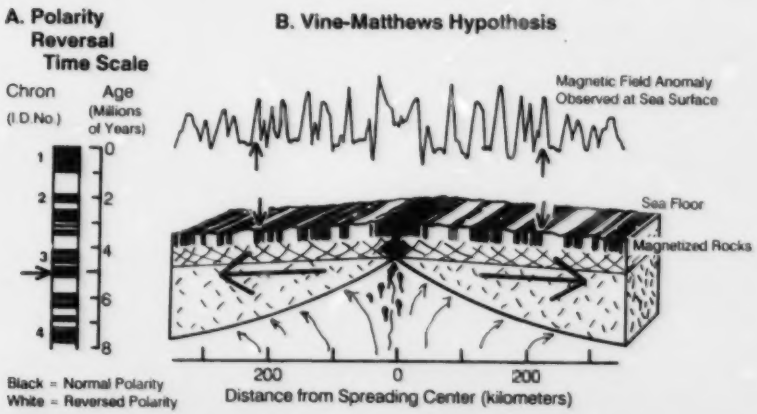

Figure 8. Vine-Matthews Hypothesis for the origin of marine magnetic anomalies. A. History of polarity reversals of the earth's magnetic field during the last 8 million years (after Berggren *et al* 1985): black = normal polarity; white = reversed polarity. B. Formation of marine magnetic anomalies. The sea floor spreads and new lava erupts and cools, becoming magnetized in the current earth's magnetic field: black = lavas magnetized during periods of normal polarity; white = lavas magnetized during periods of reversed polarity. A ship crossing on the ocean surface measures a "magnetic anomaly", which is the magnetic field that is perturbed by local fields from the magnetized rocks. These anomalies are interpreted to give sea floor age. For example, arrows indicate 5 million year age on the polarity time scale, on the sea floor on both sides of the spreading centre, and on the corresponding sea-surface magnetic anomalies.

resulting magnetic stripes faithfully record these variations in their variable widths. Furthermore, since sea floor spreading generally occurs symmetrically, the patterns are symmetrical across the spreading centres. The magnetized stripes, in turn, cause a predictable striped pattern of perturbations in the magnetic field at the ocean surface, the "magnetic anomalies", and these can be measured by ships, identified and mapped to produce an isochron map of the sea floor.

The isochron map of the northeast Pacific was recently updated by Atwater and Severinghaus (1989) (Fig. 9). For the most part, in this region we have only the isochron patterns embedded in the Pacific Plate. We deduce spreading histories between the Pacific and its neighbouring plates by assuming that seafloor spreading was symmetrical and that the Pacific isochrons are half the pattern, the symmetrical halves of which were embedded in the adjacent plates, since subducted. With this assumption, we can conclude that there were at least

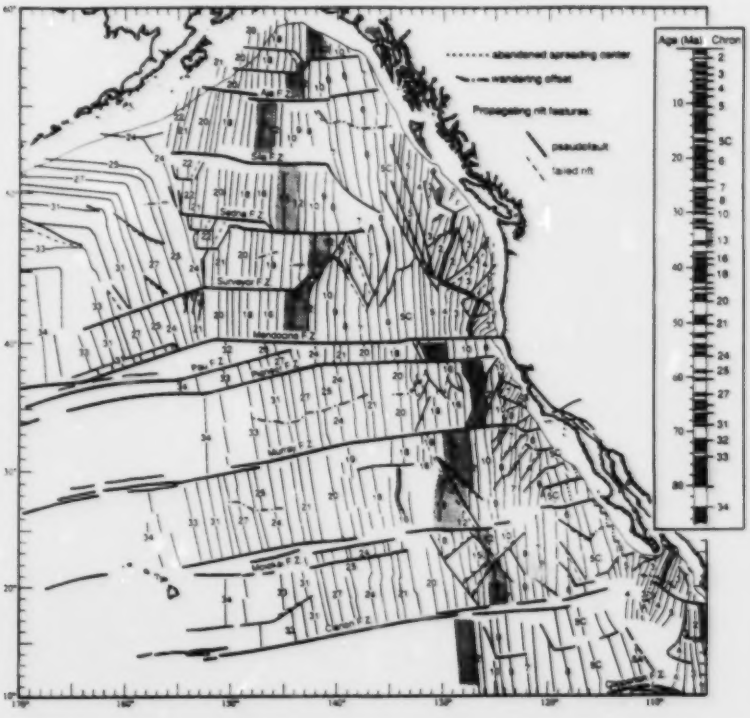

Figure 9. Isochrons of the northeast Pacific sea floor (after Atwater and Severinghaus 1989). Anomaly identification numbers (chrons) can be translated to ages in millions of years (Ma) using the magnetic polarity timescale (from Berggren *et al* 1985) on the right. Sea floor aged 33 to 37 Ma is shaded to bring out offset patterns.

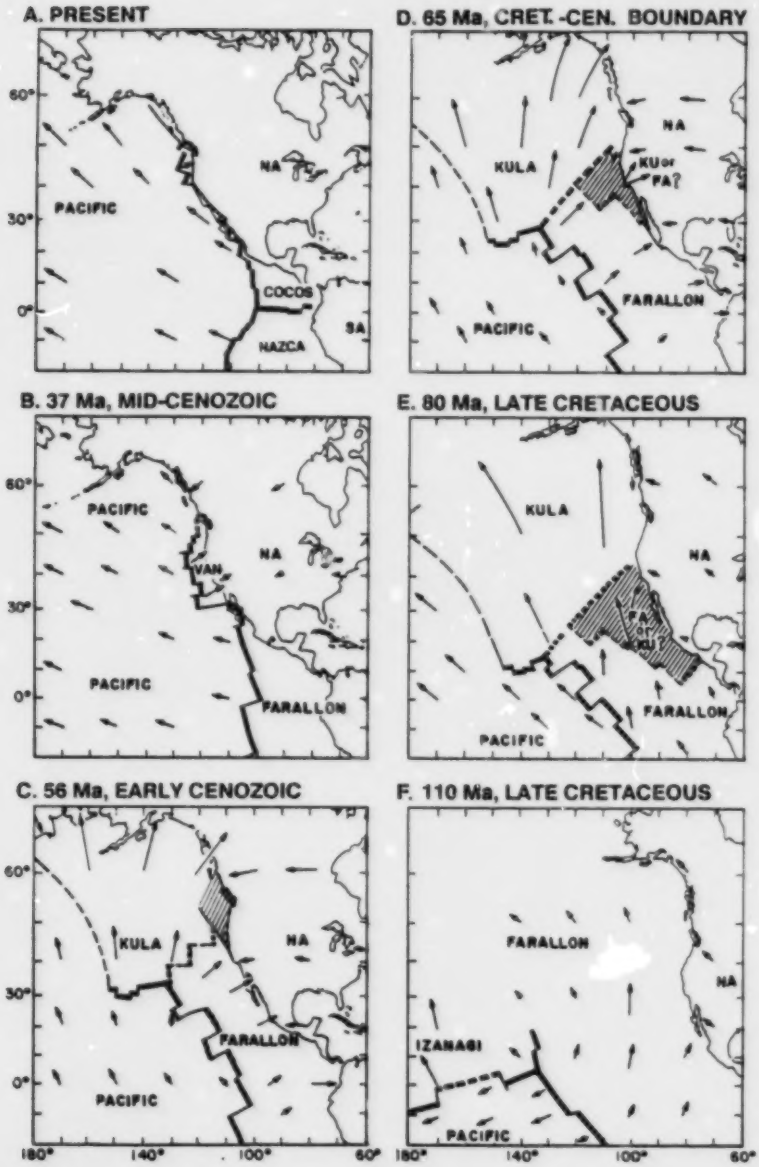

Figure 10. Generalized reconstructions of Pacific ocean plate locations and velocities for selected times since the late Cretaceous (after Engebretson *et al* 1985). Shaded area on C, D, and E shows region of ambiguity arising from the unknown location of the Kula-Farallon spreading centre.

three oceanic plates in the north Pacific basin in the late Cretaceous, the Pacific, Kula, and Farallon plates (Fig. 10). By combining the measured displacements among these plates with global solutions, we can estimate their locations and displacements through time with respect to North America[2] (Engebretson *et al* 1985) (Fig. 10). The isochrons in Figure 9 were formed during spreading of the Kula and Farallon plates away from the Pacific plate and thus they reveal the relative motions among these plates. The east-west isochrons south of the Aleutian trench constitute the Kula-Pacific record. It is quite limited in area and in age range, but none-the-less, it is of great interest because it shows that the Kula plate was moving northward very rapidly. When the Pacific-Kula relative plate motions are added to estimated Pacific absolute plate motions, it appears the Kula plate moved about 2000 kilometres northward between about 85 and 60 Ma (Lonsdale 1988, Mammerickx and Sharman 1988, Atwater 1989). A late Cretaceous fast northward sprint is inferred for a number of North American terranes, discussed below, and the Kula plate is their likely transporter.

Most of the isochrons in Figure 9 were formed by seafloor spreading between the Pacific plate and the Farallon plate or its descendents. When combined with global reconstructions this record documents a voluminous, long-term history of subduction beneath North America followed by a gradual, stepwise transition from subduction to the modern strike-slip dominated regimes.

Continental Geologic Record of Subduction

A primary manifestation of subduction that can be found in the continental geologic record is the presence of rocks formed from arc magmas. These can be arc volcanic rocks, similar to those erupting in the Cascades and Alaska today. More commonly, the ancient volcanic rocks have been lost to erosion and we find their deep seated roots, the granitic batholiths. Extensive subduction-related granitic terranes (such as those that form the spectacular walls of Yosemite Valley) are found inboard all along the Pacific rim. The ages of these igneous rock bodies show us that subduction was extensive and long term, occurring throughout the Mesozoic and into the Cenozoic, and they corroborate plate reconstructions that require the subduction of thousands of kilometres of oceanic lithosphere during that time period.

In the western United States this magmatic record is disrupted at about 80 Ma (latest Cretaceous) by the Laramide orogeny. Magmatism ceased in California and new, patchy magmatic events appear as far east as Colorado. At the same time, the western states experienced a major compressive event, resulting in the faulting and uplifting of the Rocky mountains. It is believed by many that this orogeny resulted from an episode of flat slab subduction, when the subducting plate levelled off beneath the North American plate instead of diving into the mantle (Coney 1976, Cross 1986). A modern example of very low angle subduction that is presently occurring beneath northern Chile and Argentina (Isacks and Barazangi 1977) has affected the

overriding South American plate in a style very similar to the Laramide disruptions (Jordon and Allmendinger 1986, Kay *et al* 1987).

Several causes have been proposed to cause a flattening of subduction in Laramide time. The calculated Farallon-North American subduction rate was exceptionally fast at that time, as was the calculated absolute overriding rate of the North American plate. While fast subduction and fast overriding are not sufficient to cause low angle subduction, they are required. The modern examples of low angle subduction beneath South America combine these factors with the additional fact that the oceanic crust that is being subducted is anomalously thickened by seamounts (and thus is extra-buoyant). Some sources of thickened oceanic crust have been postulated for the early Cenozoic Farallon plate but, of course, these are long ago suducted so that they will always be uncertain.

The Canadian Rockies also suffered major compressive events in the Cretaceaous. These may be similar to the Laramide events to the southeast, but they are also, certainly, affected as well by the dockings of various terranes described below.

Disintegration of the Farallon plate and origin of the San Andreas and Queen Charlotte plate boundaries

In the Cretaceous, the Farallon plate was huge, probably filling half the Pacific Ocean. Coming forward in time, as the Pacific-Farallon spreading centre approached the Americas, this plate gradually narrowed then broke into smaller pieces (Fig. 10.) The present day Explorer, Juan de Fuca, south Gorda, Cocos, Nazca, and Easter plates can all be considered descendents of the ancient Farallon plate. As the plate disintegrated, the smaller plates became less stable in their motions. This can be seen very clearly in Figure 9, since the isochrons and their offsetting fracture zones can be thought of as fossil spreading centres and their offsetting transform faults. The older isochrons and fracture zones such as those shaded on Figure 9 form the relatively tidy orthogonal patterns expected for stable spreading systems. The younger isochron patterns, along the rim of North America, are full of transverse structures created as the small unstable plated moved away from the Pacific plate with more variable directions and rates (Atwater 1989).

Along the rim of North America, the approach and arrival of the Pacific-Farallon spreading centre resulted in the gradual replacement of the old subduction system by the modern transform-dominated regimes. The geometry of this transition is reasonably well documented by the isochron patterns, especially for the San Andreas system (Fig. 11). The Pacific-Farallon spreading system and the subduction zone at the margin of North America slowly approached one another until segments south of the Mendocino fracture zone began to meet (Fig. 11D). As a result of this meeting, a portion of the intervening plate was annihilated and a new boundary between the Pacific and North American plates (the San Andreas system) was established. The first portions of the San Andreas boundary were established off southern California and northern Baja California about 25 Ma millions of years (Fig. 11C). Sub-

sequently, this plate boundary extended southeastward in a stepwise manner as each segment of the spreading centre arrived at the trench while, simultaniously, it migrated northwestward reflecting the Pacific plate motion past North America (Figs. 11B and 11A).

The history of the Queen Charlotte transform system is less well known than that of the San Andreas because many of the relevant seafloor isochrons have been lost to subduction. The spreading centres at the north end of the Juan de Fuca (or Vancouver) plate also approached and met the subduction zones, but in this case the southeastward extension and northwestward drift occurred at about the same rate so that the meeting point lay approximately in its present location, off northern Vancouver island, at least as long ago as 30 Ma (Fig. 11D). Through all the subsequent time, a predominantly strike-slip Pacific-North America plate boundary is postulated for the Queen Charlotte region. The earlier history of the Queen Charlotte fault can not even be guessed from the seafloor record, since this record has subsequently been destroyed (Figs. 11F-11H).

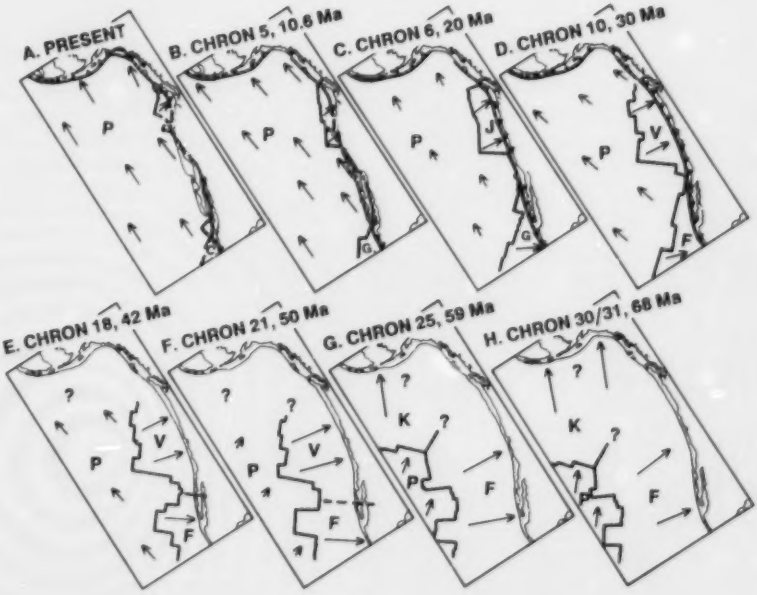

Figure 11. Detailed reconstructed plate locations and velocities in the northeast Pacific ocean basin for selected chrons in the Cenozoic at approximate 10 million year intervals (after Stock and Molnar 1988). Pacific plate (P), Farallon plate (F), Vancouver plate (V), Guadalupe plate (G), Juan de Fuca plate (J), Cocos plate (C).

Far Travelled Terranes of the North American Rim

One of the most interesting tectonic aspects of northwestern North America concerns the geologic makeup and origin of the continental landmass itself. Detailed mapping reveals that it consists of many disparate terranes, each a few tens to a few hundred kilometres in dimension, and each carrying a unique record as to its origin and travels. The western United States, British Columbia, and Alaska all contain numerous accreted terranes. Alaska, alone, contains as many as thirty, the Yakutat terrane being the latest addition to this Alaskan collage (Fig. 12).

The terranes carry, in their geologic records, many clues as to their origins and subsequent histories. Some appear to be fragments of old continents, torn off and rafted across the ocean. Others are oceanic in character, believed to have started life as oceanic island arcs, plateaus, or island chains like the modern Hawaiian chain (Howell *et al* 1985). Many have complicated travel histories. For example, the following scenario is suggested for the Alexander (ALX), Wrangelia (WRN), and Peninsular (PEN) terranes. ALX and WRN drifted into the southern hemisphere in the Paleozoic. They collided with one another and with PEN and the resulting superterrane moved rapidly northward (Penuska and Stone 1985), docking against North America in the vicinity of present day Cape Mendocino in mid-late Cretaceous time (Coe *et al* 1985). They were then dismembered and shifted as slivers northwestward

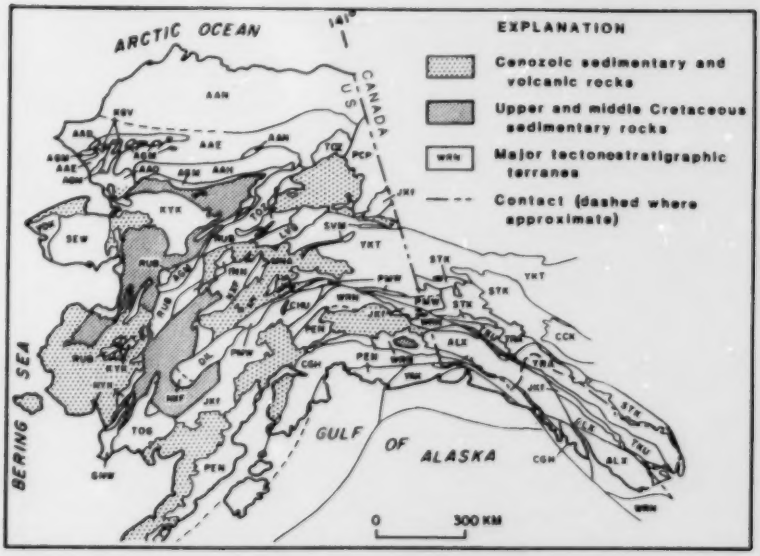

Figure 12. Far-travelled terranes of northwestern North America (from Howell *et al* 1985). Labels distinguish terranes, each of which has a distinct geologic history. Travel scenario for the Alexander (ALX), Wrangellia (WRN) and Peninsular (PEN) terranes is described in the text.

along the continental rim. By the early Cenozoic they had arrived near their present positions in British Columbia and Alaska (numerous segments labelled ALX, WRN, and PEN on Figure 12). The fast northward movements of these terranes suggest that they travelled embedded in the Kula plate and, after docking, were dragged along the continental rim, partially coupled to the Kula plate (Debiche *et al* 1987). Each of the other terranes identified in Figure 12 is likely to have just as complicated a history and the unravelling of the history of each of these requires the intricate integration and cross-understanding of data from diverse geologic disciplines, from paleomagnetism to paleontology.

ENDNOTES

1. The largest, Magnitude 9.5, occurred along the subduction interface beneath southern Chile in 1960.
2. It should be noted in passing that in the older reconstructions of Figure 10, a vast area of unknown oceanic plate fills the entire north Pacific. In these reconstructions we extrapolate the known plates into this area, but we could just as well postulate additional oceanic plates and boundaries, all of which have been subducted.

BIBLIOGRAPHY

Algermissan, S.T., Rinehart, R.W., Sherburne, R.W., and Dillinger, W.H., Preshocks and aftershocks of the Prince William Sound earthquake of March 28, 1964, in Leipold, L.E., ed., *The Prince William Sound, Alaska, Earthquake of 1964 and Aftershocks*, U.S. Coast & Geodetic Survey, 1969, pp. 79-130.

Atwater, B.F., Evidence for great Holocene earthquakes along the outer coast of Washington state. *Science*, v. 236, 1987, pp. 942-944.

Atwater, B.F., West, D.O., and McCrumb, D.R., Comment and Reply on "Coastline uplift in Oregon and Washington and the nature of Cascadia subduction-zone tectonics". *Geology*, v. 16, 1988, pp. 952-953.

Atwater, T.M., Plate Tectonic history of the northeast Pacific and western North America. In Winterer, E.L., Hussong, D.M., and Decker, R.W., eds., *The Geology of North America*, v. N. The Eastern Pacific Ocean and Hawaii. Boulder, Colorado: Geological Society of America, 1989, pp. 21-72.

Atwater, T.M. and Severinghaus, J., Tectonic maps of the northeast Pacific. In Winterer, E.L., Hussong, D.M., and Decker, R.W., eds., *The Geology of North America*, v. N: The Eastern Pacific Ocean and Hawaii. Boulder, Colorado: Geological Society of America, 1989, pp. 15-20.

Barrett, T.J. and Fox, J.S., Seafloor hydrothermal mineralization. *The Canadian Mineralogist*, v. 26, 1988, pp. 429-430.

Berggren, W.A., Kent, D.V., Flynn, J.J., and van Couvering, R.A., Cenozoic geochronology. *Geological Society of America Bulletin*, v. 96, 1985, pp. 1407-1418.

Carver, G. and Burke, R.B., Active convergent tectonics in northwestern California. In Aalto, K.R. and Harper, G.D., eds., *Geologic Evolution of the Northernmost Coast Ranges and Western Klamath Mountains, California*, Field Trip Guidebook T308. Washington, D.C.: American Geophysical Union, 1988, pp. 64-82.

Coe, R.S., Globerman, B.R., Plumley, P.W., and Thrupp, G.A., 1985, Paleomagnetic Results from Alaska and Their Tectonic Implications. In Howell, D.G., ed., *Tectonostratigraphic terranes of the Circum-Pacific region*, Amer. Assoc. of Petro. Geologist, pp. 85-108.

Coney, P.J., Plate tectonics and the Laramide orogeny. *New Mexico Geological Society, Special Publication*, v. 6, 1976, pp. 5-10.

Cox, A.V. and Hart, R.B., *Plate Tectonics: How it Works*, Blackwell Scientific Pub., Inc., 1986, 392 p.

Cross, T.A., Tectonic controls of foreland basin subsidence and Laramide style deformation, western United States. *International Association of Sedimentologists, Special Publication*, v. 8, 1986, pp. 15-39.

Crowell, J.C., The recognition of transform terrane dispersion within moble belts. In Howell, D.G., ed., Tectonostratigraphic Terranes of the Circum-Pacific Region. *Earth Science Series*, Number 1, 1985, C.-Pac. Coun. Energy & Min., Houston, Texas.

Daniels, G.E., Lewis, T.A., and Editors, *Planet Earth, Volcano*. Alexandria, Virginia: Time-Life Books, 1982, 176 p.

Darienzo, M.E. and Peterson, C.D., Episodic tectonic subsidence of late Holocene salt marshes, northern Oregon central Cascadia margin. *Tectonics*, v. 9, 1990, pp. 1-22.

Debiche, M.G., Cox, A., and Engebretson, D.C., The Motion of Allochthonous Terranes across the Pacific Basin. *Geological Society of America Special Paper 207*, 1987, 49 p.

De Mets, C., Gordon, R.G., Argus, D.F., and Stein, S., Current plate motions. *Geophysical Journal*, v. 101, 1990, pp. 425-478.

Didyk, B.M. and Simoneit, B.R.T., Hydrothermal oil of Guaymas basin and implications for petroleum formation mechanisms. *Nature*, v. 342, 1989, pp. 65-89.

Duncan, R.A. and Kulm, L.D., Plate Tectonic Evolution of Cascades arc-subduction complex. In Winterer, E.L., Hussong, D.M., and Decker, R.W., eds., *The Geology of North America*, v. N. The Eastern Pacific Ocean and Hawaii. Boulder, Colorado: Geological Society of America, 1989, pp. 413-138.

Ellsworth, W.L., Lindh, A.G., Prescott, N.H., and Herd, D.C., The 1906 San Francisco earthquake and the seismic cycle. In Simpson, D.W. and Richards, P.G., eds., Earthquake Prediction, an International Review; *Maurice Ewing Series 4*, American Geophysical Union, Washington, D.C., 1981, pp. 126-140.

Engebretson, D.C., Cox, A., and Gordon, R.G., Relative motions between oceanic and continental plates in the Pacific basin, *Geological Society of America Special Paper 206*, 59 p.

Gill, J., *Orogenic Andesites and Plate Tectonics*, Springer-Verlag, Berlin and New York, 390 p.

Goter, S.K., *Global Distribution of Seismicity, 1977-1986*; National Earthquake Information Cente, U.S. Geological Survey, Denver, Colorado, 1987.

Harris, R.A., Iyer, H.M., and Dawson, P.B., Imaging the Juan de Fuca plate beneath southern Oregon using teleseismic P-wave residuals, *Journal of Geophysical Research*, v. 96, 1991, pp. 19,879-19,889.

Haymon, R.M., Hydrothermal processes and products on the Galapagos Rift and East Pacific Rise. In Winterer, E.L., Hussong, D.M., and Decker, R.W., eds., *The Geology of North America*, v. N. The Eastern Pacific Ocean and Hawaii. Boulder, Colorado: Geological Society of America, 1989, pp. 125-144.

Howell, D.G., Jones, D.L., and Schermer, E.R., Tectonostratigraphic terranes of the circum-Pacific region. In Howell, D.G., ed., Tectonostratigraphic Terranes of the Circum-Pacific Region, *Earth Science Series*, No. 1, 1985, Circum-Pacific Council for Energy and Mineral Resources, Houston, Texas, pp. 3-30.

Isacks, B.L. and Barazangi, M., Geometry of Benioff zones: lateral segmentation and downward bending of the subducted lithosphere. In Talwani, M. and Pitman, W.C., eds., Island Arcs, Deep Sea Trenches, and Back-Arc Basins, *Maurice Ewing Series, No. 1*, American Geophysical Union, Washington, D.C., 1977, pp. 99-114.

Jordan, T.E. and Allmendinger, R.W., The Sierras Pampeanas of Argentina: a modern analogue of Rocky Mountain foreland deformation. *American Journal of Science*, v. 286, 1986, pp. 737-764.

Kanamori, H., Rupture process of subduction-zone earthquakes. *Annual Reviews of Earth and Planetary Sciences*, v. 14, 1986, pp. 293-322.

Kay, S.M., Maksaev, V., Moscoso, C., Mpodozis, C., and Nasi, C., Probing the evolving Andean lithosphere: mid-late Tertiary magmatism in Chile (29-30.5 degrees south) over the modern zone of subhorizontal subduction. *Journal of Geophysical Research*, v. 92, 1987, pp. 6173-6189.

Lay, T. and Kanamori, H., The asperity model and the nature of large subduction zone earthquakes. *Earthquake Prediction Research*, v. 1, 1982, pp. 3 70.

Lisowski, M. and Atwater, B.F., Seismic Potential of Cascadia Subduction Zone, Symposia I and II. *EOS, Transactions*, American Geophysical Union, v. 68, 1987, pp. 1239-1241, 1467-1469.

Lonsdale, P., Paleogene history of the Kula Plate: Offshore evidence and onshore implications. *Geological Society of America Bulletin*, v. 100, 1988, pp. 733-754.

Lonsdale, P., Geology and tectonic history of the Gulf of California. In Winterer, E.L., Hussong, D.M., and Decker, R.W., eds., *The Geology of North America*, v. N. The Eastern Pacific Ocean and Hawaii. Boulder, Colorado: Geological Society of America, 1989, pp. 499-522.

Lonsdale, P. and Becker, K., Hydrothermal plumes, hot springs, and conductive heat flow in the Southern Trough of Guaymas Basin. *Earth and Planetary Science Letters*, v. 73, 1985, pp. 211-225.

MacDonald, K.C., Tectonic and Magmatic processes on the East Pacific Rise. In Winterer, E.L., Hussong, D.M., and Decker, R.W., eds., *The Geology of North America*, v. N. The Eastern Pacific Ocean and Hawaii. Boulder, Colorado: Geological Society of America, 1989, pp. 93-110.

Mammerickx, J. and Sharman, G.F., Tectonic evolution of the North Pacific during Cretaceous Quiet Period. *Journal of Geophysical Research*, v. 93, 1988, pp. 3009-3024.

Michaelson, C.A. and Weaver, C.S., Upper mantle structure from teleseismic P-wave arrivals in Washington and northern Oregon. *Journal of Geophysical Research*, v. 91, 1986, pp. 2077-2094.

Penuska, B.C. and Stone, D.B., Latitudinal motion of the Wrangellia and Alexander terranes and the Southern Alaska superterrane. In Howell, D.G., ed., Tectonostratigraphic Terranes of the Circum-Pacific Region, *Earth Science Series*, No. 1, 1985, Circ.-Pac. Coun. Energy & Min. Res, Houston, Texas, pp. 109-120.

Peter, J.M. and Scott, S.D., Mineralogy, composition, and fluid-inclusion microthermometry of seafloor hydrothermal deposits in the southern trough of Guaymas basin, Gulf of California. *The Canadian Mineralogist*, v. 26, 1988, pp. 567-587.

Plafker, G., Tectonic deformation associated with the 1964 Alaska earthquake. *Science*, v. 148, 1965, pp. 1675-1687.

Riddihough, R., Recent movements of the Juan de Fuca plate system. *Journal of Geophysical Research*, v. 89, 1984, 6980-6994.

Riddihough, R. and Hyndman, R.D., Queen Charlotte Islands margin. In Winterer, E.L., Hussong, D.M., and Decker, R.W., eds., *The Geology of North America*, v. N. The Eastern Pacific Ocean and Hawaii. Boulder, Colorado: Geological Society of America, 1989, pp. 403-411.

Rona, P.A., Hydrothermal mineralization at oceanic ridges. *Canadian Mineralogist*, v. 26, 1988, pp. 431-465.

Sclater, J.G., Anderson, R.N., and Bell, M.L., Elevation of ridges and evolution of the central eastern Pacific. *Journal of Geophysical Research*, v. 76, 1971, pp. 7888-7915.

Sieh, K., Stuiver, M., and Brillenger, D., A more precise chronolgy of earthquakes produced by the San Andreas fault in southern California. *Journal of Geophysical Research*, v. 94, 1989, pp. 603-623.

Sleep, N.H. and Rosendahl, B.R., Topography and tectonics of mid-oceanic ridge axes. *Journal of Geophysical Research*, v. 84, 1979, pp. 6831-6839.

Stevenson, A.J., Scholl, D.W., and Vallier, T.L., Tectonic and geologic implications of the Zodiac Fan, Aleutian abyssal plain, northeast Pacific. *Geological Society of America Bulletin*, v. 94, 1983, pp. 259-273.

Stock, J. and Molnar, P., Uncertainties and implications of the late Cretaceous and Tertiary position of North America relative to the Farallon, Kula, and Pacific Plates. *Tectonics*, v. 7, 1988, pp. 1339-1384.

Sykes, L.R., Aftershock zones of great earthquakes, seismecity gaps, and earthquake prediction for Alaska and the Aleutians. *Journal of Geophysical Research*, v. 76, 1971, pp. 8021-8041.

Sykes, L.R., Kisslinger, J.B., House, L., Davies, J., and Jacob K.H., Rupture zones and repeat times of great earthquake along the Alaska-Aleutian arc, 1784-1980. In Simpson, D.W. and Richards, P.G., eds., *Earthquake Prediction, An International Review*; Maurice Ewing Series 4, American Geophysical Union, Washington, D.C., 1981, pp. 73-80.

Sykes, L.R. and Quittmeyer, R.C., Repeat times of great earthqakes along simple plate boundaries. In Simpson, D.W. and Richards, P.G., eds., *Earthquake Prediction, An International Review*; Maurice Ewing Series 4, American Geophysical Union, Washington, D.C., 1981, pp. 217-247.

Walker, B. and Editors, *Planet Earth, Earthquake*. Alexandria, Virginia: Time-Life Books, 1982, 176 p.

West, D.O. and McCrumb, D.R., Coastline uplift in Oregon and Washington and the nature of Cascadia subduction-zone tectonics. *Geology*, v. 16, 1988, pp. 169-172.

Yamagushi, D.K., Wookhouse, C.A., and Reid, M.S., Tree-ring evidence for synchronous rapid submergence of the southwest Washington coast 300 years B.P. *EOS, Transactions*, American Geophysical Union, v. 69, 1989, pp. T31A-26.

Yorath, C.J. and Hyndman, R.D., Subsidence and thermal history of the Queen Charlotte Basin. *Canadian Journal of Earth Sciences*, v. 20, 1983, pp. 135-159.

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History of Marine Resources of the Northeast Pacific Since the Last Glaciation†

INTRODUCTION

The marine biota along the coast of northwest North America is the result of a long history of interaction among physical, biotic and human elements. The northeast Pacific (Fig. 1), especially the zone between the continental shelf and the shoreline, has undergone profound physical change since glacial ice left the area (Clague 1981) and has been subject to significant human activity long before the coming of European and Asian immigrants during the historic period (Fladmark 1982).

In this paper we relate the history of marine fauna of the northeast Pacific with focus on the nearshore zone. Important marine resources such as molluscs, salmonids and inshore fishes are directly linked to the environments of the coastal zone. To set the stage we outline the history of the physical environment first. Knowledge of the dynamic physical setting allows us to speculate about the character and distribution of marine biota where there is no direct fossil record. We then describe the history of marine biota based on data from the fossil record and from remains in archaeological sites. Both records are incomplete and selective, but they provide tangible evidence of species and indications of their abundance. We follow this with a discussion of the significance of and lessons from past relationships between native peoples and the marine realm before the arrival of later immigrants.

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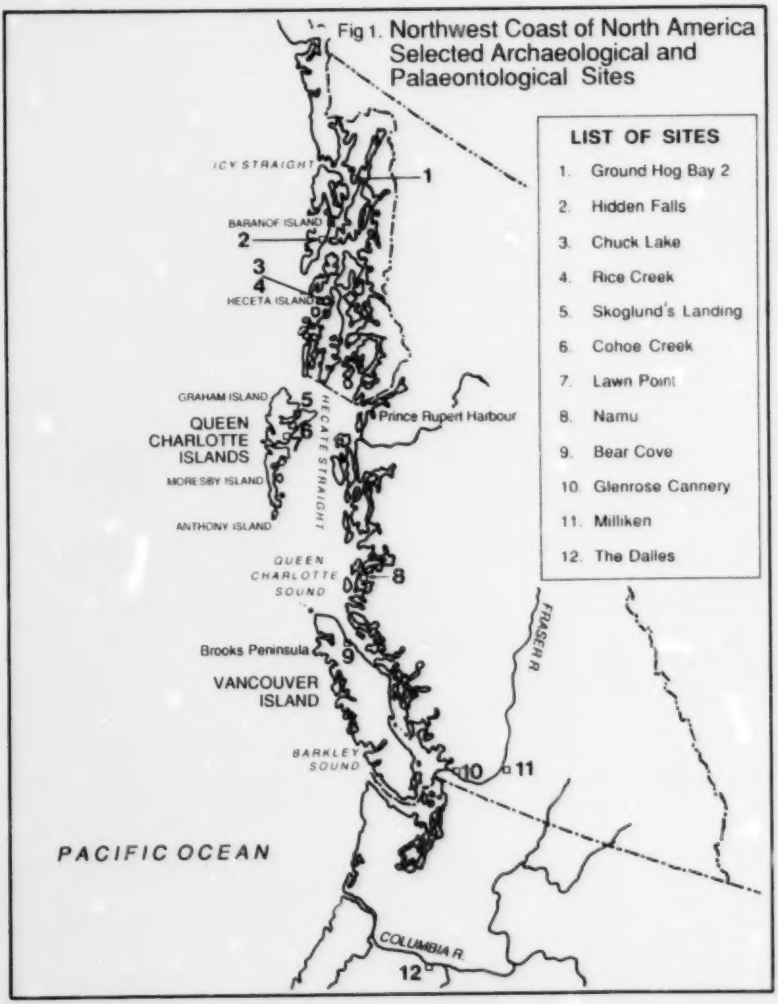
Fig 1. Northwest Coast of North America
Selected Archaeological and
Palaeontological Sites
LIST OF SITES
1. Ground Hog Bay 2
2. Hidden Falls
3. Chuck Lake
4. Rice Creek
5. Skoglund's Landing
6. Cohoe Creek
7. Lawn Point
8. Namu
9. Bear Cove
10. Glenrose Cannery
11. Milliken
12. The Dalles
ICY STRAIGHT
BARANOF ISLAND
HECETA ISLAND
GRAHAM ISLAND
QUEEN CHARLOTTE ISLANDS
MORESBY ISLAND
ANTHONY ISLAND
HECATE STRAIGHT
Prince Rupert Harbour
QUEEN CHARLOTTE SOUND
Brooks Peninsula
VANCOUVER ISLAND
BARKLEY SOUND
FRASER R.
PACIFIC OCEAN
COLUMBIA R.

HISTORY OF NORTHEAST PACIFIC ENVIRONMENT

The marine environment, especially the nearshore zone, has experienced major changes since the end of the last glaciation 12,000 to 14,000 years ago. Its history can be divided into three progressively more stable intervals: Phase I — 14,000 to 10,000 B.P.; Phase II — 10,000 to 5,000 B.P.; and Phase III 5,000 to 0 B.P.

Phase I: 14,000 to 10,000 B.P.

Rapid sea-level change and high sediment and meltwater discharge characterized this unstable time at the end of the Fraser Glaciation. From its maximum extent at about 15,000 B.P., the Cordilleran Ice Sheet began to waste away (Clague 1981). With the exception of parts of the Queen Charlotte Islands, northwest Vancouver Island and areas south and northwest of the glacial zone, sheets and rivers of ice ground away at the terrestrial surface and transported great volumes of coarse to fine debris into valleys and onto the continental shelf. Piedmont ice and ice tongues extended far out onto the shelf, especially off southwestern Vancouver Island (Herzer and Bornhold 1982). Prominent during deglaciation was the deposition of great thicknesses of glacial marine deposits, sediments which consist predominantly of clay and silt, within which occur scattered drop stones released by floating ice, and occasional shells. These sediments are widely distributed in the Georgia Depression of southwestern British Columbia but also occur along much of the glaciated coast (Clague 1981). The high rate of fine sediment input reduced light penetration and must have affected the character of marine nearshore benthic and planktonic communities.

Sea-level change during the first phase was nothing short of dramatic. Sea levels began 100 metres below the present mark but rose because of increased ocean volume resulting from melting ice. Along the glaciated coast, especially where ice volume and thickness were greatest, the weight of the ice depressed the earth's crust isostatically. As the ice melted away, the shoreline was at first inundated; then the crust rebounded very rapidly with as much as 200 metres upward adjustment at the heads of inlets and valleys (Clague *et al.* 1982). Thus along much of the glaciated coast there was little opportunity for the development of stable shore and subtidal environments. Recent discoveries of drowned terrestrial deposit off the north end of Vancouver Island indicate that sea-level changes continued at a rapid pace until as late as 10,000 years ago (Lutenauer *et al.* 1989).

Rapidly changing sea levels and continued discharge of large sediment volumes from wasting ice and unstable deglaciated landscapes had profound effects on rivers, streams and estuaries. Water courses at first carried great quantities of clay, silt and coarse outwash debris. Many large streams probably had an unstable, braided form. Furthermore, the stream gradients changed rapidly as they adjusted to fluctuating sea levels. In the period soon after ice disappeared, the landscape had an oversteepened profile covered in unconsolidated glacial debris. This initially sparsely vegetated landscape was subject

to catastrophic mass wasting and provided large volumes of coarse sediment to streams and rivers (Clague *et al.* 1983). Inland, glaciated terrain contained numerous large glacial lakes such as those in the Thompson River Valley (Clague 1981). At one time during deglacation, waters of today's Thompson River system flowed out through the Okanagan Valley into the Columbian system. The Columbian system itself was subject to catastrophic flooding as evidenced by the scablands of eastern Washinton.

Along the less intensively glaciated west coast and possibly on a now-submerged, unglaciated coastal plain, there may have been small, relatively stable streams, outside of today's fiords and fiord valleys, which were then filled with ice.

No comprehensive studies document offshore conditions during Phase I. Studies by Wagner (1959), Smith (1970) and Balzarini (1983) of foraminifera and molluscs from glacial marine deposits from Alaska to Washington State reveal that nearshore water temperatures were colder than today and salinities between 15 per cent and 35 per cent during deglaciation. Salinity and temperature varied considerably depending on local geography and proximity to melting ice.

Open-ocean conditions during Phase I differed considerably from those present in the northwest and central Pacific today, as circulation, ocean temperatures and shore ice patterns adjusted from those at the glacial maximum to those of postglacial time. The record for the northeast Pacific is poor, so we present only a general account.

The North Pacific at about 18,000 years ago experienced strong winter cooling, incomplete warming in summer and marked seasonal constrast (Sancetta 1979). This was particularly so along the Subarctic Front which marks the boundary between the sub-arctic cyclonic gyre to the north and the sub-tropical anticyclonic gyre to the south. About 14,000 years ago the sharp contrast along the sub-arctic front became reduced, especially in the eastern part of the North Pacific. With this came the development of the Transitional Domain, the oceanographic zone which today includes the waters adjacent to the coast of North America (Sancetta 1979). Sancetta (1981) also observed that during the glacial maximum shelf sea-ice was much more extensive and long lasting (6-9 months) in the eastern Bering Sea. We might expect that similar conditions occurred, at least in the nearshore zone, in the Gulf of Alaska.

Phase II: 10,000 to 5,000 B.P.

By 10,000 years ago, relative stability came to the coastal environments of the northeast Pacific. The enormous discharge of debris from glacial systems declined and indeed ended in most areas. Glaciers retreated to icefields in mountains and no longer supplied fresh cold water to dilute coastal oceanic waters. Atmospheric temperatures increased to levels about 2°C warmer than those of today (Heusser *et al.* 1985); presumably, at least inshore waters were well warmed.

Sea level no longer fluctuated as rapidly as in the late-glacial interval, but there still were significant changes. Along the coast of southwestern British Columbia, sea levels at first continued declining, reaching a low of at least 10 meters below today's mark approximately 8,000 years ago. How long sea levels remained near a relatively fixed mark is not clear. Between 7,000 and 5,000 years ago relative sea levels rose to a position near the present mark (Clague *et al.* 1982). Estuaries, shorelines and the lower stretches of some valleys were inundated. Significantly, at least in the Fraser Delta, it seems that the delta surface was able to keep pace with sea-level rise (Williams and Hebda 1991). Consequently some estuarine environments persisted in place.

In the Queen Charlotte Islands and on northwestern Vancouver Island, relative sea level reached a maximum in Phase II (Clague *et al.* 1982). Hebda and Mathewes (1986) recorded that sea levels on Anthony Island reached about 12 to 15 meters, where a marked shoreline feature developed. Sea levels started dropping from the maximum soon after 8,000 B.P. leaving behind strandline environments and estuaries, causing downcutting of streams and rivers in the search for a new marine level.

The sea-level changes in Phase II must have had considerable effect on nearshore marine resources, not only because there was an upward and downward shift in marine habitats, but also because there were significant changes in geography. In the south, as sea levels rose, new islands were formed, extant islands became smaller, new regional and local circulation patterns arose. Likely, the shallow-water, relatively low-gradient, intertidal and subtidal belt expanded over the relatively flat terrestrial surface built up by stream and strandline deposition. Such a shallow water zone might be expected to warm up significantly during the summers, especially as terrestrial atmospheric temperatures were still warmer than present (Heusser *et al.* 1985). High levels of biological productivity might be anticipated in these shallow zones.

On the Queen Charlotte Islands the land area reached maximum extent about 8,000 B.P., but increased as sea level declined. As in the south, local circulation patterns changed and the distribution of shoreline environments shifted. During this interval estuarine and tidal areas moved up and down slopes according to regional sea-level trends. The rates of change, however, were likely slow enough to allow for biotic dispersal. The landscape became well stabilized by vegetation, and rivers and streams established relatively stable floodplains.

Open-ocean physical conditions in the northeast Pacific were probably little different from those of today since it seems that modern circulation patterns were more or less established (Sancetta 1979). However, detailed study of cores near the northeast North American coastline is needed.

Phase III: 5,000 to 0 B.P.

The physical characteristics of the marine realm became stable between 5,000 years ago and the present. The shoreline, shoreline habitats and geography reached their modern configurations. Sea levels in many areas settled to

within 2 metres of today's mark early in the interval, though land areas such as the west coast of Vancouver Island exhibited 4 or more metres of rise, largely because of tectonic uplift (Clague *et al.* 1982). Shoreline and adjacent shallow water features developed relatively mature forms. Wide intertidal and subtidal platforms of varying character formed along much of the coastline, but especially in the south. Features that became well established included sand and cobble beaches and major estuarine systems such as the Fraser River Delta. Considerable thicknesses (6 metres +) of fine sediments accumulated in quiet lagoons such as those in Barkley Sound on the west side of Vancouver Island (Hebda unpublished).

River and stream systems established stable downstream courses, although some fluctuation in distributary channels likely continued. With the relative sea-level equilibrium most rivers and streams probably developed extensive estuarine zones, especially in the south where fine mineral and biogenic sediments accumulated upon deltaic platforms already built up during Phase II.

Near shore temperatures remained relatively warm because of large areas of shallow water, although there may have been some decline from the preceding interval as average annual atmospheric temperatures seem to have declined by 2°C (Heusser *et al.* 1985).

RECONSTRUCTING THE HISTORY OF MARINE RESOURCES

We can gain insight into the historical record of marine resources from four perspectives: 1. fossil record; 2. archaeological sites; 3. ethnographic record; 4. inferences based on analogy using modern organisms and environments and knowledge of past physical conditions.

The fossil record for the northeast Pacific has not been well studied. Little is known of the off-shore zone because apparently few deep sea cores have received attention to give us insight into the environments of the open ocean and because preservation, at least for diatoms, is poor and stratigraphy is difficult to interpret (Sancetta 1979). There is a good fossil record of molluscs and foraminifera from near-shore glacial marine deposits, mainly 13,000 to 11,500 years ago (Wagner 1959; Smith 1970; Balzarini 1983). There are many exposures of glacial marine sediment of this age with well-preserved fauna, particularly in southwestern British Columbia and adjacent Washington State (Wagner 1959).

The fossil record for the 10,000 to 5,000 B.P. interval is very poor. Scattered single site discoveries provide limited insight, although a comprehensive study of cores and raised marine and shoreline deposits would prove fruitful. In this context, raised marine deposits on the Queen Charlotte Islands and west Vancouver Island hold considerable potential. Similarly, little effort has been devoted to late Holocene deposits (5,000 to 0 B.P.).

Archaeological records are good sources of information about post-Pleistocene marine resources. By their very nature, archaeological deposits provide a biased record, because they contain marine animals culturally selected from

a much larger natural population of resources. Nevertheless, archaeological deposits preserve species that were present in sufficient quantities to become regular components of the diet.

The evidence that survives is of two kinds: 1. the direct evidence of body parts of animals, including teeth, bones, scales, shells and other exoskeletons; and 2. the indirect evidence from tools used to obtain or process resources. Examples of tools include: harpoon heads of bone or antler armed with shell, stone or bone tips for sea mammal hunting and fishing; fish hooks; tiny bone barbs set into poles used as "rakes" to impale small schooling fish such as herring; girdled stones inferred to be net weights; ground slate or mussel shell knives for cutting fish; bone bipoints used as gorge hooks for diving birds.

The record of marine resources from archaeological sites is particularly good for the last 5,000 years. More than 80 per cent of the coastal archaeological sites in British Columbia sit within 10 metres of the present shoreline (Hebda and Powell, unpublished). Many of these contain hundreds of cubic metres of debris, mostly shell. Furthermore, there are detailed faunal lists for many of these sites (Calvert 1980, Calvert and Crockford 1982, Ham 1982, Wigen and Stucki 1988) and they provide insight into the incredibly rich treasure that supplied the underpinnings for a complex and dynamic series of coastal cultures. Sites and their enclosed artifacts provide insight into the social dimension of the relationships between prehistoric inhabitants and the marine realm.

Ethnographic observations by early visitors, inhabitants and researchers reveal even more about marine resources and peoples' perceptions of, relationships to and uses of them (Barnett 1955; Boas 1895, 1897, 1898, 1909, 1916; Drucker 1951; McIlwraith 1948; Swanton 1905). The ethnographic record includes written historical materials and oral traditions which put marine resources within the cultural context of the inhabitants to whom they were so important. Notably ethnographic observations demonstrate which tools were used to procure marine resources and how they were used; essential information needed to interpret archaeological artifacts.

For some elements of the marine realm we have little or no direct information, yet by careful and considered uses of modern analog, we can surmise aspects of their history. For example, we can make suggestions about primary productivity based on ocean water temperature and amount of suspended matter. Or we can generalize about infaunal intertidal-subtidal molluscs in relation to shoreline stability and habitat availibility.

HISTORY OF MARINE RESOURCES

Phase I: 14,000 to 10,000 B.P.

All the late glacial macroscopic and microscopic faunal assemblages studied to date were deposited in shallow water approximately 0-30 metres deep (Wagner 1959; Smith 1970; Balzarini 1983). The assemblages contain molluscs (Table 1) of varied affinities, but clearly representing environments cooler than today. Pelycypods such as *Nuculana fossa* (Baird), *Clinocardium*

Table 1: Common marine molluscs recovered from late Pleistocene deposits of British Columbia and Washington State

Taxon	Reference		
	Wagner (1959)	Balzarini (1983)	Hebda (Victoria area unpublished data)
Pelecypods			
Nucula tenuis (Montagu)	"		
Nuculana fossa (Baird)	"	"	"
Nuculana minuta (Fabricius)	"	"	
Chlamys rubida (Hinds)	"	"	
Mytilus edulis Linné	"	"	
Clinocardium blandum (Gould)	"	—	
Clinocardium ciliatum (Fabricius)	"	"	
Clinocardium nuttallii (Conrad)	"	"	
Serripes groenlandicus (Bruguiere)		"	
Saxidomus gigantea (Deshayes)	"	"	"
Protothaca staminea (Conrad)	"	"	
Macoma calcarea (Gmelin)	"	"	
Macoma incongrua (Martens)	"	—	
Macoma nasuta (Conrad)	—	"	
Mya truncata Linné*	"		
Hiatella arctica (Linné)	"	"	"
Gastropods			
Acmaea digitalis Rathke, in Eschscholtz	"		
Trichotropis cancellata (Hinds)	"	"	
Natica clausa Broderip and Sowerby	"	"	
Turbonilla sp.	"	"	
Annelida			
Serpula vermicularis Linné	"	"	
Cirripedia			
Balanus spp.	"	"	
Echinoidea			
Strongylocentrotus dröbachiensis (Miller)	"		

nuttalli (Conrad) and *Hiatella arctica* (Linné) are well represented in late-Pleistocene deposits. *Serpula vermicularis* (Linné), worm tubes and barnacle shell fragments are encountered frequently. Gastropods occur less aburdantly. Several edible molluscs such as the butter clam [*Saxidomus gigantea* (Deshayes)], native littleneck [*Protothaca staminea* Conrad)] and bay mussel (*Mytilus edulis*, Linné), that served as important food resources to prehistoric peoples and today, occurred abundantly as soon as ice left the area.

Wagner (1959) concluded that the assemblages were representative of a marine climate similar to that in the vicinity of Cook Inlet and Prince William Sound. Cooler marine environments along the coast are consistent with a prediction from model simulations (COHMAP 1988), and conclusions from diatom studies that there may have been prolonged and extensive shelf ice in the Bering Sea (Sancetta 1981).

Furthermore, marine productivity in the Bering Sea was low as Phase I, the period of deglaciation, began. For the Gulf of Alaska and waters off the coast of British Columbia we have no definitive record of primary productivity, but perhaps we can assume that with lower water temperatures and high sediment input, (and reduced radiation in euphotic zones) that productivity was lower than today. The negative role of suspensed sediment was likely exacerbated because of the glacial melt and sediment discharge. According to Hobson (1980), along our coast, greatest observed marine primary productivity occurs during spring and summer because of greatest insolation. This is precisely the time when greatest glacial melting occurs, and presumably, suspended sediment has its strongest light filtering effect.

For other important marine resources we have no record. There are no fish remains nor other marine vertebrate remains from this interval. We can, however, speculate about salmonids, based on the nature of the streams entering the ocean from melting ice masses. At first there could have been no salmonids, or spawning areas in any of the main river systems. Most of these were likely choked with ice until about 13,000 years ago and many until 10,000 to 11,000 years ago. Then, as ice retreated up the respective valleys, the newly emerging river beds must have been completely unstable, prone to sudden catastrophic channel changes and washout. Heavy silt and clay loads would have provided an inhospitible environment for the fish (summarized in Gibbons and Salo 1973). Furthermore, with rapidly changing sea level, streams and rivers would either be rapidly aggrading or eroding. Small streams and rivers in unglaciated zones within the northern and southern limits of the Cordilleran Ice Sheet, especially on the now drowned continental shelf may well have supplied suitable habitat during full-glacial time and as deglaciation began. But many of these (at least in the south) were rapidly inundated by rising eustatic sea levels over an isostatically depressed coastal zone. Presumably salmon spawned in streams north and south of major zones of glacial activity, such as Beringia and the U.S. Pacific Northwest coast.

By 11,000 years ago much of the coastal zone was ice-free except for some major fiord valleys where ice persisted and indeed may have readvanced (Clague 1981). The rate of sea-level change, at least in the south, was declining

and streams were probably able to build relatively stable courses. It is during this time that salmon populations likely became established along the coast.

For Phase I the archaeological record provides no direct evidence of human use of marine faunal resources, although a number of undated archaeological sites suggest human occupation of the coastal region prior to 10,000 B.P. (Fladmark 1982, p. 104-106).

Stone artifacts found in the Zone III assemblage of the Skoglund's Landing site and in the present intertidal zone at a number of locations in the southern Queen Charlotte Islands have been interpreted as remnants of settlement occurring before the rise in sea level and inundation of the coastal zone around 9,500 years ago (Fladmark 1982; Hobler 1978, p. 2). In southwestern British Columbia, unifacial pebble tool artifacts of the Pasika Complex are found on raised terraces in the Fraser River Canyon near Yale possibly associated with geological deposits inferred to be 10,000 to 11,000 years old (Borden 1975, p. 55-59).

None of these sites has produced organic remains, nor are the lithics artifacts recovered sufficiently diagnostic to indicate exploitation of marine resources. The locations of the northern lithic sites, however, suggest a maritime cultural orientation. The Yale locality in the Fraser River Canyon is today a major salmon fishing centre.

Phase II: 10,000 to 5,000 B.P.

In contrast to the preceding 5,000 years, little is known about the marine resources of this interval from the fossil record. There are few marine deposits of this age above sea level except in the northern part of the area. What little we know comes from chance finds in a few scattered cores. There were sardines [*Sardinops sagax* (Jenyns)] in Saanich Inlet on Vancouver Island about 9,000 years ago (Casteel 1975), pile perch about 7,000 years ago and a well developed *Salicornia* salt marsh 7,500 years ago in Barkley Sound (Hebda, unpublished).

At the Rice Creek Locality in the Alaska Panhandle (Table 2), marine clay/till deposits on the 2 metre bench have produced a sample of mollusc shell radiocarbon dated to 9,410 ±130 B.P. The fauna contains species that have been present in the region since the late Pleistocene. Included are the false Pacific jingle *Pododesmus macroschisma* (Deshayes)], basket cockle *Clinocardium nuttalli* (Conrad)], thin-shelled littleneck *Protothaca tennerima* (Carpenter)], butter clam *Saxidomus gigantea* (Deshayes)] and bay mussel [*Mytilus edulis* (Linné)] (Ackerman 1985, p. 161-162).

The achaeological record, however, is very informative. During this interval people came to occupy the coast from southeast Alaska to the Columbia River and some of these people depended on the marine realm for food. At least eight deep, multilayered, multicomponent sites, whose earliest layers are securely radio-carbon dated between 10,000 and 7,000 B.P. have now been excavated on the northwest coast (Table 2).

The Dalles site, 150 miles inland on the Columbia River in Oregon, is the earliest stratified site with faunal remains from the initial occupation layers,

dating to 10,000 B.P. or possibly older. A very few vertebrate faunal remains were recovered from the lowest levels but great quantities of salmon (*Oncorhynchus* sp.) vertebrae, bird bones, and mammal bones were recovered higher up in the sequence (Cressman 1960, p. 59). The most frequently occurring birds include gulls (Laridae), condors (*Gymnogyps californianus*), cormorants (*Phalacrocorax* sp.) and bald eagle [*Haliaeetus leucocephalus* (Linnaeus)], all species one might expect to feast on spawning salmon.

These data establish the presence of salmon runs (species unknown) in the Columbia River by at least 8,000 and probably as much as 9,000 years ago. Consequently, even though the Columbia channeled vast quantities of sediment and debris-laden meltwater from wasting ice from southeastern British Columbia during Phase I, salmon were established in the system by 9,000 to 8,000 years ago. Presumably salmon already occupied similarly suitable rivers to the north in recently deglaciated terrain, having moved into these areas as conditions became suitable.

An archaeological deposit in the Alaska Panhandle establishes the presence of marine molluscs and fish at the northern end of the study area at about the same time (Table 2). At Chuck Lake Locality 1 on Heceta Island, a shell midden records that people used molluscs, fish, migratory waterfowl, sea birds and marine and terrestrial mammals (Ackerman 1985, p. 150). Mollusc species present include basket cockle, native littleneck [*Protothaca staminea* (Conrad)], butter clam and Bay mussel (Ackerman 1985, p. 161-162).

Clearest evidence of the intensive use of marine resources by early peoples along the entire coast appears between 6,000 and 5,000 years ago. At the Glenrose Cannery Site, Fraser Delta, the upper layers of the earliest component, now estimated to be about 5,700 years old, yielded a few bones of harbour seal (*Phoca vitulina* Linnaeus), some marine birds, including loon (*Gavia* sp.), Western grebe [*Aecmophorus occidentalis* (Lawrence)], and diving ducks (Aythyinae); marine and anadramous fish, including flatfish (Pleuronectidae), eulachon [*Thaleichthys pacificus* (Richardson)] and salmon; and very small amounts of shellfish, including bay mussel, barnacle (*Balanus* sp.), California mussel [*Mytilus californianus* (Conrad)], butter clam, basket cockle and thin-shelled littleneck (Matson 1976, p. 111). Bay mussel is by far the most frequently occurring shellfish. Though the faunal assemblage is predominantly terrestrial, marine resources constitute an important element of the diet.

Deposits at Bear Cove, northeastern Vancouver Island, 6,500 to 5,000 years old, yielded: the sea mammals porpoise or dolphin (Delphinidae), Northern fur seal [*Callorhinus ursinus* (Linnaeus)], Northern sea lion [*Eumetopias jubatus* (Schreber)], sea otter [*Enhydra lutris* (Linnaeus)] and harbour seal; the marine fish, rockfish (*Sebastes* sp.), Pacific cod [*Gadus macrocephalus* (Tilesius)], pollock [*Theragra chalcogramma* (Pallas)], sculpin (Cottidae), greenling (*Hexagrammos* sp.), dogfish [*Squalus acanthias* (Linnaeus)], ratfish [*Hydrolagus colliei* (Lay and Bennet)] and salmon; and some sea birds, including diving ducks, loons, gulls and common murres [*Uria aalge* (Pontoppidan)] (Carlson 1979). Although there are no shellfish in these

layers, the general character of the assemblage suggests considerable reliance on marine resources.

At Namu, on British Columbia's central coast, abundant vertebrate faunal remains 6,500 and 5,000 years old, include: dolphin, porpoise, sea otter, Northern fur seal, Northern sea lion and harbour seal. There are also herring [*Clupea harengus* (Valenciennes)], cod (Gadidae), flatfish, rockfish, sablefish [*Anoplopoma fimbria* (Pallas)], greenling, sculpin, ratfish, dogfish and salmon, and unidentified marine birds. A single small shell lens occurs in these layers although the species present are not reported. The site demonstrates considerable exploitation of salmon as 80 per cent of the fish bones belong to this group. Bone artifacts from these layers include unilaterally barbed harpoon heads; unilaterally barbed fish hooks; and bone barbs for composite bone/wood or bone/stone fish hooks (Carlton 1979, p. 214; Cannon 1989, p. 21, Table 2). For these people the marine environment probably provided a considerable portion of their subsistence.

Three more sites provide evidence of the use of marine resources in this time period: the Cohoe Creek Site near Port Clements on the Queen Charlotte Islands, and Chuck Lake Localities 2 and 3 on Heceta Island in the Alaska Panhandle (Table 2). At the Cohoe Creek Site, sand and gravel layers between pea-gravel dated to about 6,000 B.P., and later shell midden layers, contain traces of barnacle, bay mussel, basket cockle, native littleneck clam, butter clam, sea urchin (*Strongylocentrotus* sp.) and a few fragments of unidentified mammal bone (Ham 1988, p. 18). It is not yet clear whether these traces of shell are truly cultural, but they may date the initial uses of these resources in the area.

The time period 6,000 to 5,000 B.P. is also represented by small shell midden deposits containing some vertebrate remains, including marine fish, at Chuck Lake Localities 2 and 3 on Heceta Island (Ackerman 1985, p. 145). Molluscs present are predominantly butter clam, native littleneck clam, basket cockle and bay mussel, very similar to the remains from the earlier deposits at Chuck Lake Locality 1 (Ackerman 1985, p. 150).

In summary, as early as 6,500 B.P., there were well established populations along the B.C. coast using a wide range of vertebrate and invertebrate marine resources. Although few sites represent this interval, further investigations, especially in the northern half of the area, will reveal more of the record of marine resources.

Table 2. Selected Archaeological and Palaeontological Sites Dating between 10,000 to 5,000 B.P. (see Figure 1)

SITE	REGION	RADIO CARBON DATES	REFERENCE
Ground Hog Bay 2	Icy Strait SE Alaska	Earliest layers Component III: 10,180 ± 800 B.P. 9,220 ± 80 B.P. 9,130 ± 130 B.P.	Ackerman 1975, p. 3; Borden 1975, p. 15
Hidden Falls	Baranoff Island Alaska Panhandle	Component I: 10,345 ± 95 B.P. 7,175 ± 155 B.P.	Davis 1984; Ackerman et al., 1979
Chuck Lake	Heceta Island Alaska Panhandle	Locality 1, Component I: 8,180 ± 130 B.P. 8,220 ± 125 B.P. Locality 3: 5,240 ± 90 B.P. Locality 2: 5,140 ± 90 B.P.	Ackerman 1985
Cohoe Creek	Near Port Clements, Queen Charlotte Islands	Layer B7: 6,150 ± 70 B.P.	Ham 1988
Lawn Point	Graham Island Queen Charlotte Islands	Component 5: 7,400 ± 140 B.P. 7,050 ± 110 B.P.	Fladmark 1986, p. 52
Namu	Central Coast near Bella Bella	Zone II a: 9,720 ± 140 B.P. 9,140 ± 200 B.P. 7,800 ± 200 B.P. Zone II b: 6,060 ± 100 B.P.	Carlson 1979, p. 214
Bear Cove	North eastern Vancouver Island, near Port Hardy	Near the bottom of Cultural deposits: 8,020 ± 110 B.P.	Carlson 1979, p. 183
Glenrose Cannery	Fraser River Delta	Old Cordilleron Components 8,150 ± 250 7,430 ± 340 6,780 ± 135	Matson 1976, p.18

Table 2. (continued)

SITE	REGION	RADIO CARBON DATES	REFERENCE
Milliken	Fraser Canyon near Yale	Zones G, H and I: 9,000 ± 150 B.П. 8,150 ± 130 B.П.	Borden 1975, п. 61
The Dalles	Columbia River Gorge, Oregon	Stratum 1, Levels 31-37: 9,785 ± 220 B.П. Levels 30 to 22: 7,875 ± 100 B.П. 7,675 ± 110 B.П.	Cressman 1960, п. 23–24
Rice Creek Locality	Heceta Island, Alaska Panhandle	Palaeontological deposit 9,410 ± 130 B.П.	Ackerman 1985, p. 161-162

Phase III 5,000 to 0 B.P.

Knowledge of the marine resources for the last 5,000 years derives from incredibly rich archaeological deposits. This is an interval of increasing impact upon the marine realm by humans, culminating in the mass exploitations of the last 150 years.

In Phase III, there is an apparent dramatic increase in the number of marine remains in archaeological deposits; this is the time when vast quantities of shellfish remains are deposited in massive shell middens (Fladmark 1982, p. 110). At previously occupied sites shell layers occur on top of primarily shell-free layers. There is often a temporal hiatus of as much as 1,000 to 1,500 years between these deposits. The transition from shell-free to shell-rich matrices appears abrupt. In sites where these deposits mark the initial occupation, shellfish remains are heavily concentrated in the earliest layers.

Numerous sites along the coast preserve marine remains of this age (Fladmark 1982). In the Fraser Delta this period is represented at both the St. Mungo Cannery Site (Boehm 1973) and the Glenrose Cannery Site (Matson 1976) beginning at about 4,300 B.P. In the Gulf Islands it is represented by the Pender Canal and Helen Point Sites dated around 5,000 B.P. (Carlson 1986); on the west coast of Vancouver Island at the Yuquot Site about 4,700 B.P. (Dewhirst 1980); on the central coast at Bear Cove and Namu beginning around 5,000 B.P.; and on the northern coast by the Prince Rupert Harbour middens at about 5,000 B.P. (MacDonald and Inglis 1981) and the Heceta Island Rosie's Rock Shelter site (Ackerman 1985), to mention only the most important. These midden sites contain quantities of marine and anadramous fish, sea mammal and sea birds remains as well as the ubiquitous molluscan remains.

At many sites the lowest layers contain proportionately more bay mussel remains than clam remains whereas clams predominate in the upper layers. The overwhelmingly most abundant clams are native littleneck and butter clam, with lesser amounts of basket cockle, horse clam (*Tresus* sp.), native Pacific oyster [*Ostrea lurida* (Carpenter)], macoma (*Macoma* sp.), thin-shelled littleneck, false Pacific jingle and purple-hinged scallop [*Hinnites multirugosus* (Gale)]. Other shellfish include sea urchins, sea snails (primarily *Thais* sp.), chitons (Polyplacophora), limpets (primary Acmaiedae) and barnacles.

Vertebrate remains reveal exploitation of marine mammals and birds, a major emphasis on marine fish and an increasing reliance on anadromous salmon. Northern fur seal, Northern elephant seal [*Mirounga angustirostris* (Gill)], harbour seal, Northern sea lion, California sea lion [*Zalophus californianus* (Lesson)], sea otter, harbour porpoise [*Phocoena phocoena* (Linnaeus)], Dall's porpoise [*Phocoenoides dalli* (True)], grey whale [*Eschrichtius robustus* (Lilljeborg)], killer whale [*Orcinus orca* (Linnaeus)] and humpback whale [*Megaptera novaeangliae* (Borowski)] have all been recovered from sites.

Marine birds represented include Western grebe [*Aecmophorus occidentalis* (Lawrence)], red-necked grebe [*Podiceps grisagena* (Boddaert)], eared grebe [*Podiceps caspicus* (Hablizl)], horned grebe [*Podiceps auritus* (Linnaeus)], common loon [*Gavia immer* (Brunnich)], red-throated loon [*Gavia stellata* (Pontoppidan)], Arctic loon [*Gavia arctica* (Linnaeus)], common murre [*Uria aalge* (Pontoppidan)], rhinoceros auklet [*Cerorhinca moncerata* (Pallas)], tufted puffin [*Lunda cirrhata* (Pallas)], marbled murrelet [*Brachyramphus marmoratus* (Gmelin)], pigeon guillemot [*Cepphus columba* (Pallas)], albatross (*Diomedea* sp.), Northern fulmar [*Fulmaris glacialis* (Linnaeus)], pale-footed and sooty shearwaters [*Puffinus carneipes* (Gould) and *Puffinus griseus* (Gmelin)], double-crested, pelagic and Brandt's cormorants [*Phalacrocorax auritus* (Lesson)], [*P. pelagicus* (Pallas) and *P. penicillatus* (Brandt)], great blue heron [*Ardea herodias* (Linnaeus)] various duck and goose species (Anatidae), black oystercatcher [*Haematopus bachmani* (Audubon)], various sandpipers (Charadriidae), many species of gulls and terns (Laridae), jaegers (*Stercorarius* sp.) and the skua [*Catharacta skua* (Brunnich)].

The list of marine fish used is equally extensive: several shark species (Pleurotremata), including dogfish [*Squalus acanthias* (Linnaeus)]; big, black, and longnose Skates [*Raja binoculata* (Girard), *R. kincaidi* (Garman) and *R. rhina* (Jordan and Gilbert)]; ratfish [*Hydrolagus colliei* (Lay and Bennett)]; sturgeon (*Acipenser* sp.); Pacific herring [*Clupea harengus* (Valenciennes)], Pacific sardine [*Sardinops sagax* (Jenyns)] and Northern anchovy [*Engraulis mordax* (Girard)]; all five species of salmon and both species of native trout (*Oncorhynchus* spp.); several species of smelt (Osmeridae) and the eulachon [*Thaleichthys pacificus* (Richardson)]; Pacific cod [*Gadus marcrocephalus* (Tilesius)], Pacific hake [*Merluccius productus* (Ayres)], Pacific tomcod [*Microgadus proximus* (Girard)] and walleye pollock [*Theragra chalcogram-*

ma (Pallas)]; threespine stickleback [*Gasterosteus aculeatus* (Linnaeus)]; several species of surfperch (*Embiotocidae*); wolf-eel [*Annarhichthys ocellatus* (Ayres)]; bluefin tuna [*Thunnus thynnus* (Linnaeus)]; numerous species of rockfish (*Sebastes* sp.); several species of sculpin (Cottidae); a number of species of poachers (Agonidae); the plainfin midshipman [*Porichthys notatus* (Girard)]; greenlings (*Hexagrammos* spp.) and ling cod [*Ophiodon elongatus* (Girard)] and nearly all the species of flatfish (Pleuronectidae and Bothidea) now occurring in these waters.

Specific emphases vary from site to site and differences are especially marked between those sites located on the outer coast and those at major river mouths. Outer coast sites exhibit greater dependence on sea mammals and a wide variety of marine fish, whereas the inshore delta sites evidence a stronger reliance on anadromous salmon.

The number of recorded sites increases sharply for the interval 3,000 B.P. to the present, most being near the present shoreline (Fladmark 1982). Future work will increase the number of earlier sites known, but the great number of post-3,000 B.P. deposits must reflect a real population expansion. This demographic change may be associated with a shift toward intensive exploitation of intertidal shellfish resources, an increasingly sedentary settlement pattern and development of food preservation technology. Possibly more shellfish habitat became available as sea level stabilized after 5,000 B.P. and extensive intertidal deposits arose (Fladmark 1983). On the other hand, most of the major mollusc species had been present in quantity before 5,000 years ago.

The apparent abrupt increase in shellfish deposition at around 5,000 to 4,000 years ago may also result from a combination of other factors. Shellfish debris deposited on the original acidic forest floor may have preserved poorly. Areas of the southern coast were below present sea levels during the 7,000 to 5,000 year time period so that middens of that interval are not visible. An increasingly sedentary settlement pattern later in Phase II may have contributed to the local accumulation of debris in one place, rather than its wider dispersal.

By about 3,000 B.P. the classic generalized Northwest Coast maritime adaptation so well known from the ethnographic record was clearly established throughout the Northwest Coast of North America from southeastern Alaska to Washington State. Differing marine resource emphases from region to region were established by this time, with a major division occurring between outer coast sites on Vancouver Island and the Queen Charlottes and inner coast sites of the eastern shores of Vancouver Island and the mainland.

LATE PREHISTORIC USE OF MARINE RESOURCES

By the late prehistoric period the coastal peoples had evolved effective adaptations to exploit the marine resources of their world, from fur seals and whales, albatross, alcids and waterfowl, halibut, herring, rockfish, cod and salmon, to all the varied molluscs available at the intertidal "dinner table". Along with this dependence on marine resources came the development of a

material culture centred on wood products, especially those of cedar. Characteristic elements of the marine-focused complex of cultures included: large wooden plank dwellings housing fifty or more people; expertly crafted canoes hewn from single massive logs; clothing, mats and basketry woven from the inner bark of cedar and the roots of spruce; a complex and sophisticated sculptural and painted art form; complex fishing and sea mammal hunting gear, from hook and line through trap and weir, harpoon and spear to reef net; and bentwood boxes wonderfully fashioned to hold everything from water to dried salmon, or to serve as burial boxes. The cultures were held together by intricate societal structures involving clan, moiety, or bilateral kin grouping; ranking of individuals and families within and between kin groups; trade and marriage networks extending over great distances; strict property ownership rules; complex social ceremonials validating rights of ownership and chieftanship; and major redistribution systems for foodstuffs and other goods.

One need only look at the huge shell midden sites marking the winter village locations of the late prehistoric period, found by the hundreds along this coast, to gain some idea of the population densities supported by and impacting the marine and anadromous resources of the coastal waters. A few examples may serve to illustrate this point.

In Barkley Sound on the west coast of Vancouver Island, lie the Broken Group Islands, scattered at the mouth of the Alberni Inlet. This region was surveyed in 1982 by the archaeology staff of the Royal British Columbia Museum (Haggarty and Inglis 1987). Today these islands are deserted. One hundred and fifty years ago they probably supported a population conservatively estimated at 5,000 people. Ten major village midden sites have been mapped on the islands as well as numerous smaller resource exploitation locations. At one site alone, twenty-one house depressions were located. The close relationship with and intimate knowledge of marine resources is revealed by the thirty-five intertidal stone-walled fishtraps located in the shallow bays and coves throughout the islands. These are deliberate modifications of the natural environment to harvest the ocean's bounty. Midden sites are filled with hundreds of cubic metres of remains of shellfish, fish, birds and sea mammals, including bones of even the enormous humpback and grey whales. Historic and ethnographic records from the late 18th and 19th centuries reveal an abundance of grey and humpback whales off the west coast of Vancouver Island. Whaling was a major economic activity of at least nine of the Nuu-chah-nulth-speaking tribal groups living on the west coast of Vancouver Island (Inglis and Haggarty 1983).

Up and down the coast there are huge shell middens of prehistoric and proto-historic age, sites 2 to 5 metres deep, up to 400 metres long and with up to four rows of house platforms. They record many years of intensive exploitation of marine resources by an increasing population. We conservatively estimate populations of 200,000 to 300,000 people on the northwest coast at first contact with Europeans.

These were maritime peoples with their woodworking technology solidly grounded in the coastal forests, but their faces set to the sea winds. Over the

centuries they evolved extremely efficient adaptations to their coastal marine environment that allowed population expansion and involved the exploitation of an extremely wide range of marine resources coupled with the intensive exploitation of a smaller number of marine resources that were available in large quantities at one time and could be stored for later consumption. Yet despite this intensive exploitation of marine fauna over centuries, as far as we know, at the beginning of the historic period, those resources were not depleted.

THE COMING OF THE EUROPEANS

When the European fur traders and explorers arrived on the Northwest Coast in the late 1700s they found rivers filled with salmon; offshore waters teeming with cod, herring and halibut; huge flocks of sea birds and a seemingly inexhaustible population of sea mammals — fur seals, sea otters, sea lions, seals, porpoises, dolphins and whales — inhabiting the coastal waters (Beaglehole 1967, Jewitt 1974, Meares 1790, Morizo 1970, Vancouver 1798). The arrival of the first sailing vessel brought the beginning of the end to this marine abundance.

Where the native fisherman had performed elaborate first salmon ceremonies to ensure next years return of the salmon (Gunther 1928) and undertook complicated rituals to entreat the "noble lady", the whale, to give herself up for food (Drucker 1951); where the native cultures recognized their interdependence with the animal world, the newcomers saw but a gold mine to be plundered for profit. And plunder they did.

English, American, Spanish and Russian trading vessels brought the fur trade. Then came pelagic sealing; then whaling; then the dog-fish oil industry; then pilchard reduction plants. As one species declined and its exploitation became no longer profitable, attention shifted to another marine resource. By the early 1900s, the short-tailed albatross [*Diomedea albatrus* (Pallas)], the Steller's sea cow, the sea otter, the Northern fur seal, the grey whale, the sperm whale [*Physeter catodon* (Linnaeus)], the humpback and the fin whale [*Balaenopiera physalus* (Linnaeus)], were all either extinct in the area, or heading for extinction. Other species were greatly reduced in numbers to but a fraction of their pre-contact population levels. In some areas introduced species, such as the Japanese oyster [*Crassostrea gigas* (Thunberg)], the Japanese littleneck clam [*Tapes philippinarum* (Adams and Reeve)] and the soft-shell clam [*Mya arenaria* (Linné)] claimed ecological niches formerly occupied by native species. The coastal peoples' intimate knowledge of and respect for the marine resources, the complex social structures and rituals, evolved over thousands of years of close contact, were nearly lost. The most profound change in the marine realm since the disappearance of the great ice sheets was wrought in the last two hundred years and today we see only an impoverished remnant of that once rich marine treasure.

SUMMARY

We can summarize the history of marine resources of the northeast Pacific during the last 14,000 years as follows:

1. Fossil deposits, archaeological deposits and ethnographic records provide insight into the history of marine resources.
2. The history of marine environments and resources is poorly known, especially for the open ocean and for the period before 5,000 years ago.
3. Major physical changes associated with deglaciation and sea-level fluctuation characterized the nearshore environment of the northeast Pacific from 10,000 to 14,000 years ago.
4. The environment became gradually more stable from 10,000 years ago to the present.
5. Most extant resources probably have been present since about 10,000 years ago.
6. There is a good record of common molluscs, fish, sea mammals and sea birds from 6,500 B.P. to the present.
7. People's use of resources intensified from generalized hunting/fishing/gathering as early as 10,000 years ago to specialized, sophisticated systems of resource management by at least 3,000 years ago.
8. The most widely used marine resources included intertidal shellfish, nearshore fish and salmonids. Sea mammals and sea birds also added significantly to the diet.
9. Until the Historic Period, the rich marine fauna supported large populations without being depleted.
10. Historic intensive over-harvesting drove some species to extinction or near extinction and drastically reduced the range and abundance of other species.

Today we live with, and use but a fraction of the once rich marine resource base, the result of selective over-harvesting during the last 200 years. We suggest that, in part, the decline in marine resources is related directly to the different social and management context of two cultural systems: that of the Native Peoples and that of Europeans. In the Native systems, the owners and managers of the resources were also the harvesters and consumers of the resources. Sustained yield was vital to survival. People had an intimate knowledge of and familiarity with their local resources. The owners, managers, harvesters and users functioned within a regional cycle with built in feedback. During historic times, the intimate relationship between these units was broken. Ownership and management fell to the harvesters, whose only motivation was to provide product to consumers far divorced from the natural source. Consumers had little stake in management since their survival was not intimately linked to the resource. Once the resource was depleted, harvesting moved to another specific resource; consumers found alternate food

or materials. There was no complex social structure linking consumers, owners, harvesters and managers into an interdependent regional whole.

Little has changed. Governments manage resources harvested by non-owners who sell through international processors to consumers, miles and oceans distant. The relationship between the resource and its consuming population is fractured, the cycle incomplete. If one adds to this the ever increasing destruction of habitat associated with industrial development, logging and pollution, and the rise of fishing technologies which literally empty the seas, the future for marine resources in comparison to past abundance seems dim. As stewards of the remnants of the once rich marine fauna of the northeast Pacific we must consider the lessons of history and strive to maintain a balanced management-harvester-consumer cycle as did the First Peoples of the north Pacific Ocean for thousands of years.

BIBLIOGRAPHY

Ackerman, Robert E., Technological Perspectives in Northern Northwest Coast Prehistory: Aspects of the Lithic Industry of the GHB 2 Site, Southeastern Alaska. Paper presented at the Conference, "Correlations of Ancient Cultures of Siberia & Adjoining Territories of the Pacific Basin". October 20-21, 1975. Akademgorodok (Novosibirsk), U.S.S.R.

Ackerman, R.E.; Hamilton, T.D.; and Stuckenrath, R., Early Culture Complexes on the Northern Northwest Coast. *Canadian Journal of Archaeology*, No. 3, 1979, pp. 195-209.

Ackerman, Robert E.; Reid, Kenneth; Gallison, James D.; and Roe, Mark E., Achaeology of Heceta Island: A survey of 16 Timber Harvest Units in the Tongass National Forest, Southeastern Alaska. *Project Report No.3*, Centre for Northwest Anthropology, Washington State University. Pullman, 1985.

Anderson, R.Y.; Hemphill-Haley, E.; and Gardener, J.V., Persistent Late Pleistocene — Holocene seasonal upwelling and varves off the coast of California. *Quaternary Research* 28, 1987, pp. 307-313.

Balzarini, M.A., Paleoecology of Late Pleistocene glacial-marine sediments in northwestern Washington and southwestern British Columbia. In B.F. Molina (Ed.) *Glacial-Marine Sedimentation*. New York: Plenum Press, 1983. pp. 571-592.

Barnett, Homer G., *The Coast Salish*. Eugene: University of Oregon Press, 1955.

Beaglehole, J.C., (ed.), The Voyage of the Resolution and Discovery, 1776-80. *Vol. 3, Pt. 1, the Journals of Captain James Cook on his Voyages of Discovery*. Cambridge University Press, 1967.

Boas, Franz, The Social Organization and Secret Societies of the Kwakiutl Indians. *Report of the United States National Museum*, 428 pp. Washington, 1895, 1897.

Boas, Franz, The Kwakiutl of Vancouver Island. *American Museum of Natural History, Memoir No. 8*. New York, 1909.

Boas, Franz, Tsimshian Mythology. *Annual Report of the Bureau of American Ethnology, No. 31.* Washington: Smithsonian Institute, 1916.

Boehm (nee Calvert) Sheila Gay, *Cultural & Non-Cultural Variation in the Artifacts and Faunal Samples from the Mungo Cannery Site, B.C., DgRr 2.* Unpublished M.A. Thesis in Anthropology & Archaeology, University of Victoria, 1973.

Borden, Charles E., Origins & Development of Early Northwest Coast Culture to about 3000 B.C. *National Museum of Man Mercury Series, Archeaological Survey of Canda Paper No. 45.* Ottawa, 1975.

Calvert, S.G., *A Cultural Analysis of Faunal Remains from Three Archaeological Sites in Hesquiat Harbour, B.C.* Unpublished Ph.D. Thesis, Dept. of Anthropology and Sociology, The University of British Columbia, 1980.

Calvert, S.G., and Crockford, S. Analysis of Faunal Remains. In A.D. McMillan and D.E. St. Claire, *Alberni Prehistory: Archaeological and Ethnographic Investigations on Western Vancouver Island.* Alberni and Penticton: Alberni Valley Museum and Theytus Books, 1982.

Cannon, Aubrey, *Quantifying Change in Archaeofauna Abundance: The Economic Prehistory of Namu, British Columbia*, 1989. MS on file Department of Anthropology, University of Toronto.

Carlson, Catherine, The early component at Bear Cove. *Canadian Journal of Archaeology*, No. 3, 1979. pp. 177-194.

Carlson, Roy L., The Early Period on the Central Coast of British Columbia. *Canadian Journal of Archaeology*, No. 3, 1979. pp. 211-228.

Carlson, R.L., *The 1985 Excavations at the Canal Site*, 1986. MS on file at the Dept. of Archaeology, Simon Fraser University, Burnaby.

Casteel, Richard, An Early Post-Glacial record of the Pacific Sardine *Sardinops sagax*, from Saanich Inlet, Vancouver Island, British Columbia. *Copeia*, No. 3, 1975. pp. 576-579.

Clague, J.J., Late Quaternary geology and geochronology of British Columbia Part 2: Summary and discussion of Radiocarbon-dated Quaternary History. *Geological Survey of Canada Paper 80-35*, 1981. 41 p.

Clague, J.J.; Harper, J.R.; Hebda, R.J.; and Howes, D.E., Late Quaternary sea levels and crustal movements, coastal British Columbia. *Canadian Journal of Earth Sciences*, No. 19, 1983, pp. 597-618.

Clague, J.J., Luternauer, J.L.; and Hebda, R.J., Sedimentary environments and post glacial history of the Fraser Delta and lower Fraser Valley, British Columbia. *Canadian Journal of Earth Sciences* No. 20, 1983. pp. 1314-1326.

COHMAP, Climatic changes of the last 18,000 years: Observations and model simulations. *Science*, No. 241, 1988. pp. 1043-1052.

Cressman, L.S., Cultural Sequences at the Dalles, Oregon. A contribution to Pacific Northwest Prehistory. *Transactions of the American Philosophical Society*, New Series, Vol. 50, Part 10. Philadelphia, 1960.

Davis, S.D., Cultural Component I. In S.D. Davis (ed.), *The Hidden Falls Site, Baranof Island*, 1984, pp. 87-124. Ms. on file, USDA Forest Service, Chatham Area Office, Sitka.

Dewhirst, John, The Yuquot Project, Volume 1. The indigenous archaeology of Yuquot, a Nootkan outside village. *History of Archaeology*, No. 39, 1980. Parks Canada, Ottawa.

Drucker, P., Northern and Central Nootkan Tribes. *Bureau of American Ethnology*, No. 144, 1951. 457 pp.

Fladmark, Knut, A paleoecological model for Northwest Coast prehistory. *Archaeological Survey of Canada, Mercury Series, Paper 43*. 1975, Ottawa.

————, An Introduction to the Prehistory of British Columbia. *Canadian Journal of Archaeology*, No. 6, 1982. pp. 95-156.

Fladmark, Knut R., A comparison of sea-levels and prehistoric cultural developments on the east and west coasts of Canada. In R.J. Nash (ed.), *The Evolution of Maritime Cultures on the Northeast and the Northwest Coasts of America*. Publication No. 11, Dept. of Archaeology, Simon Fraser University.

————, Lawn Point and Kasta: Microblade sites on the Queen Charlotte Islands, British Columbia. *Canadian Journal of Archaeology*, Vol. 10, 1986. pp. 39-58.

Gibbons, D.R., and Salo, E.O., An annotated bibliography of the effects of logging on fish of the Western United States and Canada. *USDA Forest Service General Technical Report PNW — 10*, 1973. 145 pp.

Gunther, Erna, A Further Analysis of the First Salmon Ceremony. *University of Washington Publications in Anthropology 2*, 1928. pp. 135-173.

Haggarty, J.C., and Inglis, R.I., Pacific Rim National Park Ethnographic History. *Parks Canada Microfiche Report Series 257*, 1987. Ottawa.

Ham, Leonard C., *Seasonality, Shell Midden Layers and Coast Salish Subsistence Activities at the Crescent Beach Site, DgRr 1*, 1982. Unpublished Ph.D. Thesis, Dept. of Anthropology and Sociology, The University of British Columbia.

————, *An Archaeological Impact Assessment of the Cohoe Creek Site (FjUb 10), Port Clements, Queen Charlotte Islands, B.C.* Report to the Heritage Conservation Branch, Ministry of Municipal Affairs, Recreation & Culture, Victoria, 1988.

Hebda, R.J., *Holocene sea-level change, Barkley Sound, Vancouver Island, British Columbia*. (unpublished) manuscript on file, Botany Unit, Royal British Columbia Museum, Victoria. 32 pp.

————, and Mathewes, R.W., Radiocarbon dates from Anthony Island, Queen Charlotte Islands, and their geological and archaeological significance. *Canadian Journal of Earth Sciences*, No. 23, 1986. pp. 2071-2076.

Herzer, R.H., and Bornhold, B.D., Glaciation and post-glacial history of the continental shelf off southwestern Vancouver Island, British Columbia. *Marine Geology*, No. 48, 1982. pp. 285-319.

Heusser, C.J.; Heusser, L.E.; and Peteet, D.M., Late-Quaternary climatic change on the American North Pacific Coast. *Nature*, No. 315, 1985. pp. 485-487.

Hobler, Philip M., The Relationship of Archaeological Sites to Sea Levels on Moresby Island, Queen Charlotte Islands. *Canadian Journal of Archaeology*, No. 2, 1978. pp. 1-13.

Hobson, L.A., Primary productivity of the North Pacific Ocean — A Review. In McNeil, W.J., and Himswoth, D.C. (eds.), *Salmonid Ecosystems of the North Pacific*. Corvalis: Oregon State University Press, 1980. pp. 231-246.

Inglis, R.I., and Haggarty, James C., *Provisions or Prestige: a re-evaluation of the economic importance of Nootka Whaling*. Paper presented at the XIth International Conference for Archaeological and Ethnological Sciences, 23 August 1983.

Jewitt, John, *The Adventure and Sufferings of John R. Jewitt, Captive Among the Nootka 1803-1805*. Toronto: McClelland and Stewart Ltd., 1974.

Lutenauer, J.L.; Clague, J.J.; Conway, K.W.; Barrie, J.V.; Blaise, B.; Mathews, R.W., Late Pleistocene terrestrial deposits on the continental shelf of western Canada: Evidence for rapid sea-level change at the end of the last glaciation. *Geology*, V. 17, 1989. pp. 357-360.

MacDonald, George F., and Inglis, Richard I., An overview of the North Coast Prehistory Project. In K. Fladmark (ed.), Fragments of the Past: British Columbia Archaeology in the 1970s, *B.C. Studies, Special Issue 48*, 1981. pp. 37-63.

McIlwraith, T.F., *The Bella Coola Indians*. Toronto: University of Toronto Press, 1948.

Matson, R.G., The Glenrose Cannery Site. *National Museum of Man Mercury Series, Archaeological Survey of Canada Paper No. 52*. Ottawa, 1976.

Meares, John, *Voyage Made in the Years 1788 and 1789 from China to the North-west Coast of America*. London: Logographic Press, 1790.

Mozino, José Mariño, *Noticia de Nutka: An Account of Nootka Sound in 1792*. Toronto: McClelland and Stewart, 1970.

Sancetta, C., Oceanography of the North Pacific during the last 18,000 years: evidence from fossil diatoms. *Marine Micro-paleontology*, No. 4, 1979. pp. 103-123.

Sancetta, C., Fossil diatoms and the oceanography of the Bering Sea during the last glacial event. Second International Conference on Siliceous Deposits of Pacific Region, Tokyo, 1981. pp. 333-345.

Smith, R.K., Late glacial foraminifera from southeast Alaska and British Columbia and a world-wide high northern latitude shallow-water faunal province. *Archives des sciences*, No. 23, 1970. pp. 675-701.

Swanton, John R., Contributions to the Ethnology of the Haida. *American Museum of Natural History, Memoir*, Vol. 5, Part 1, 1905. 300 pp. New York.

Vancouver, George, *A Voyage of Discovery to the North Pacific Ocean and Round the World, performed in the years 1790, 1791, 1792, 1793, 1794 and 1795*. 3 Vols. London: G.S. and J. Robinson and J. Edwards, 1798.

Wagner, F.J.E., Palaeoecology of the Marine Pleistocene faunas of Southwestern British Columbia. *Geological Survey of Canada Bulletin*, No. 52, 1959. 71 pp.

Wigen, Rebecca J., and Stucki, Barbara R., Taxonomy and Stratigraphy in the Interpretation of Economic Patterns at Hoko River Rockshelter. In *Research in Economic Anthropology, Supplement 3, Prehistoric Economics of the Pacific Northwest Coast* edited by Barry Isaac. London: Jai Press Ltd., 1988.

Williams, H.F.L., and Hebda, R.J., Palynology of Holocene top-set, aggradational sediments of Fraser River Delta, British Columbia. *Paleogreography, Paleoclimatology and Paleoecology*, No. 86, pp. 297-311.

PAUL H. LeBLOND, F.R.S.C., and
KEITH A. THOMSON*

The North Pacific Ocean Environment†

The ocean hides its secrets under a cloak of superficial uniformity. Seen from the shores of British Columbia, the Pacific offers a monotonous grey perspective stretching to the far horizon. The feeling of uniformity is enhanced by flying over the ocean: at 10,000 m the eye perceives more than 10,000 square kilometres of empty wavy sea.

Although overwhelming on the human scale, the ocean, with an average depth of about 5 km, is but a thin, watery film on the Earth's surface. The Pacific stretches more than 10,000 km from east to west: in its width and thickness, it is best compared to a sheet of paper! Nevertheless, this thin, apparently featureless, fluid sheet is many times more massive than the Earth's atmosphere and plays an extremely important role in the life of our planet.

Oceanographers have learned to recognize subtle differences in water properties and have patched together a fragmentary picture of the behaviour of the oceans. We present here a simplified overview of the oceanography of the North Pacific, beginning with the broad features of the surface and of the deep circulation. We then discuss recent observations of the variability of ocean currents and how they have forced oceanographers to re-evaluate their understanding of the oceanic environment.

THE GEOGRAPHY OF THE NORTH PACIFIC OCEAN

Vertical profiles of temperature and salinity in the Pacific reveal two distinct regions (Fig. 1). At the surface, a thin upper layer (about 100 m thick), of relatively warm water is in direct contact with the atmosphere. This is the part of the ocean where life abounds, from microscopic unicellular plants to schools of migrating fish and whales. Below lies the bulk of the ocean, colder and saltier masses of denser, dark waters, only indirectly linked with the atmosphere, and inhabited mainly by scavengers of the detritus which rains down from above.

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† Presented at the symposium, "Marine Resources of the North Pacific", University of Victoria, 6 June 1990.

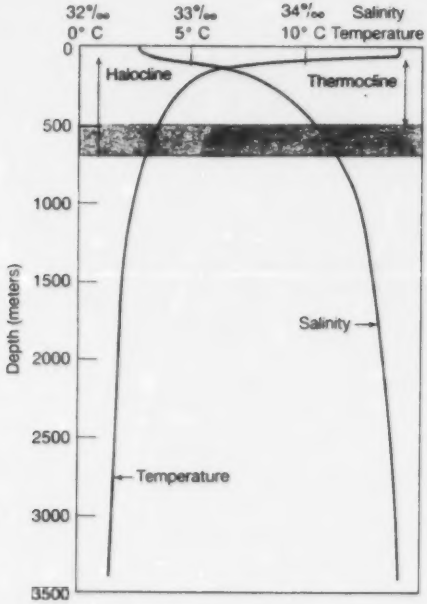

Figure 1. Schematic vertical profiles of temperature and salinity in the Northeast Pacific. The thermocline and the halocline are respectively vertical ranges over which there are pronounced changes in temperature and salinity (from Duxbury & Duxbury 1984).

The upper layer is in intimate contact with the atmosphere and follows its seasonal variations, warming up in the summer months and cooling again in the winter (Fig. 2). The winds drive a system of surface currents which form broad trans-oceanic gyre patterns (Fig. 3) characterized by strong coastal currents on the western boundaries and weak return flows everywhere else (Tabata 1975, 1976). The sub-polar gyre of the North Pacific consists of segments of strong (up to 1 m/s) southwestward flows along the coasts of the Alaskan peninsula, Kamchatka and the Kuriles, returning slowly (at speeds of 0.1 m/s and less) eastward across as the North Pacific Drift to a weak northward flow in the Gulf of Alaska. To the south, the clockwise sub-tropical gyre consists of the strong Kuroshio flowing northeastward along the coasts of [illegible]an and Japan, joining the North Pacific Drift towards the weak [illegible]ard California Current and westward returning North Equatorial Current. Stommel (1948) was the first to explain the dynamics behind the striking east-west asymmetry of the large-scale ocean circulation. A compendium of early papers on the wind-driven ocean circulation is to be found in Robinson (1963); a modern overview of studies of oceanic circulation is presented in Willebrand and Anderson (1986). For a description of the Kuroshio, the Japanese equivalent of the Gulf Stream, see Stommel and Yoshida (1972).

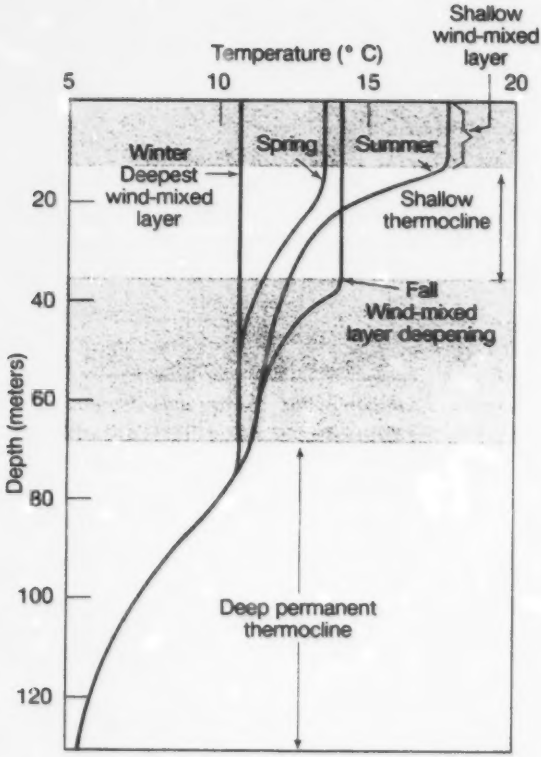

Figure 2. Schematic representation of seasonal variability of the upper layer vertical temperature profile in the Northeast Pacific (from Duxbury & Duxbury 1984).

Without entering into the description of finer details of the circulation, we note two interesting features. First, off the coast of Japan, where cold Oyashio waters meet the warm Kuroshio, there is a strong north-south gradient of water temperature: as much as 10°C in a few kilometres in some places. As one travels eastwards, this gradient weakens: off the coast of North America, the same temperature difference is found over a separation of hundreds of kilometres. There is thus considerable north-south mixing of waters as the eastward components of the two gyres join hands on their way across the ocean. The other point is that at a speed of 0.1 m/s or less it takes about three years for surface water to cross the North Pacific. During that time, it has been alternately warmed and cooled through at least two seasonal cycles (as shown in Fig. 2) and has reached thermal equilibrium with the atmosphere. It is thus quite incorrect to think of a "Japanese Current" warming up the northwest coast of North America. Surface waters off the coast of British Columbia are

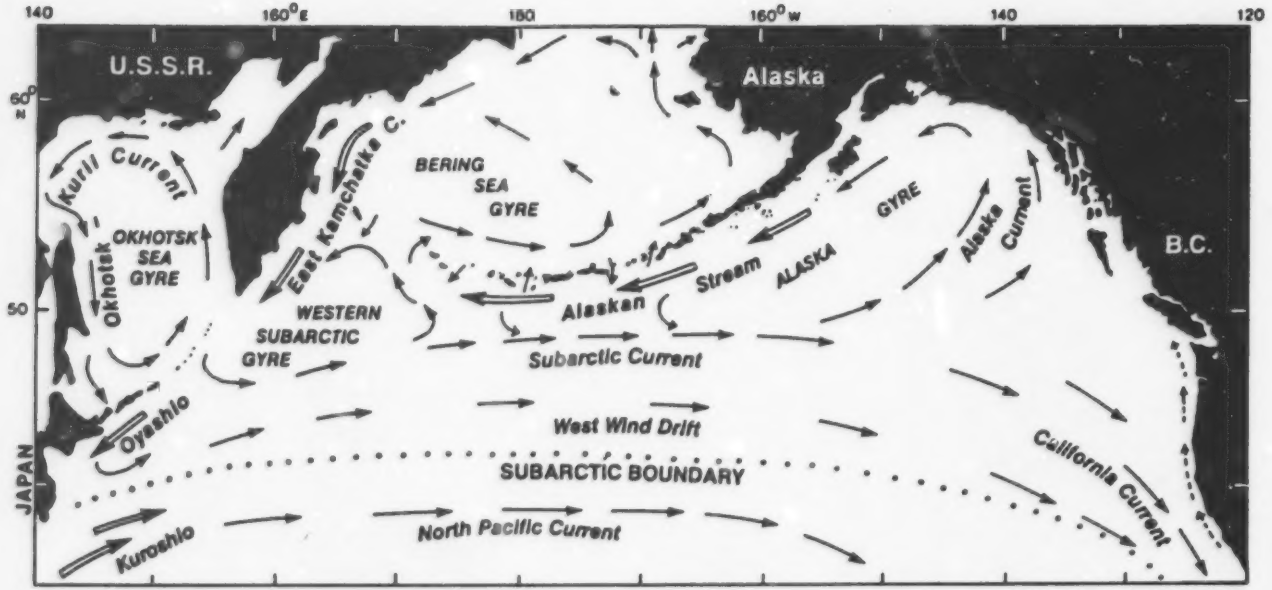

Figure 3. Schematic representation of main surface currents in the sub-arctic North Pacific. Typical flow rates are of the border of 10 cm/s (approx. 10 km/d) except in western boundary currents (double arrows), where they may reach or exceed 100 cm/s. The sub-polar gyre, its sub-components (Alaska Gyre, Bering Sea Gyre, western sub-arctic gyre), and western boundary currents (Alaska Stream, East Kamchatka Current, Oyashio) are fully described; only the northern half of the sub-tropical gyre is shown (from Thomson 1981).

mostly influenced by local processes: local winds and solar radiation, freshwater runoff and coastal upwelling. The warm winters experienced on the coast are due as much to the protective effect of a mountain barrier, which keeps cold arctic air away from the coast, as to the moderating influence of a relatively warm ocean.

The deeper ocean also partakes in a circulation pattern which is similar but much weaker than that driven by the wind at the surface. In addition, and of extreme importance, is a slow large-scale movement driven by the sinking of cold, salty waters in the North Atlantic and near the shores of Antarctica. This thermohaline circulation connects the atmosphere to the deep ocean; as sketched in Figure 4, the great oceanic conveyor belt (Broeker and Peng 1982) recirculates heat and other properties through the ocean basins. Estimates of the time taken by a water particle to travel from the North Atlantic to the North Pacific, at the most remote part of its circuit, range from 600 to 1,500 years. That is the time scale for changes in the deep ocean, which has most of the accessible heat capacity of the Earth's surface. No wonder the oceans play such an important role in climate change over long time scales!

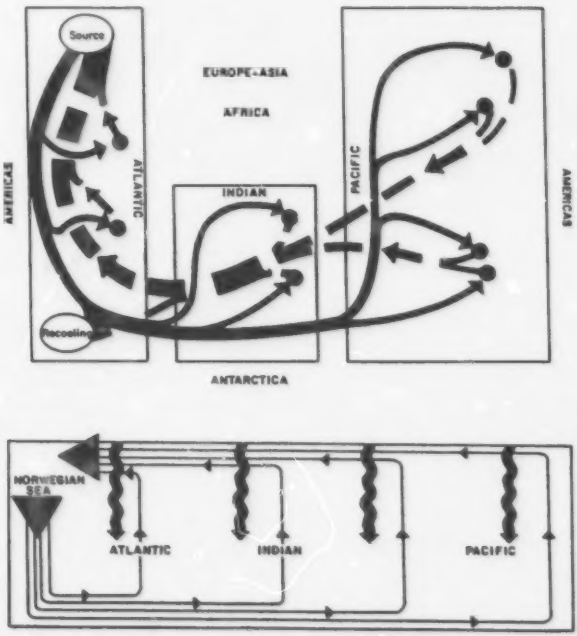

Figure 4. The great oceanic conveyor belt of Broeker and Peng (1982). Sinking takes place in two polar regions: the North Atlantic and Antarctica. Deep flow (solid arrows) percolates to the rest of the world ocean, slowly resurging upwards over broad oceanic areas to return (dashed lines) to the sinking areas.

Deep and surface layers communicate where surface waters sink or where subsurface waters upwell. No surface waters sink to great depths in the Pacific. There is evidence, however, that a mixing of subsurface waters at the boundary between the Oyashio and the Kuroshio is the source of the North Pacific Intermediate Water (Reid 1965) which sinks to 600 m or so in the area east of Japan and slowly spreads southwards. Upwelling on the other hand occurs mainly due to the action of the wind near coastlines. Upwelled waters, along the coast in the summer for example, bring to the surface waters from depths of 200 to 500 m, below the level where light is abundant and plants grow. These nutrient-rich, upwelled waters fertilize the upper layers and lead to areas of enhanced productivity. Except in some nearshore areas, then, there is very little vertical exchange of water in the North Pacific.

A CLOSER LOOK AT CURRENT VARIABILITY

The large-scale picture is very comforting. However, one must remember that it is to a great extent an idealization of more complex processes. Those smoothly arranged arrows on atlases of mean currents owe as much to an artistic representation of flow continuity as to actual data. A closer look at the temporal variability of ocean currents shows that they are as variable as the winds of the atmosphere and that atlases of "mean currents" are about as useful in predicting tomorrow's flows as are maps of annual mean atmospheric circulation in forecasting tomorrow's winds. Satellite-mounted instruments have also shown us the great spatial variability of ocean properties. The widely spaced ship-based sampling of the ocean from which most of our information has been gathered misses much of this variability in space and time. It was Walter Munk (1989) who recently referred to the "first century of oceanography as one hundred years of undersampling". It was really only with the advent of satellite remote-sensing that oceanographers discovered the degree of spatial inhomogeneity of the ocean. Before that, many of our large-scale interpretations may simply have been aliases of a smaller-scale variability beyond the resolution of our sampling.

The areas where oceanic variability was first discovered were those of the great western boundary currents, where it is most pronounced. The Gulf Stream and its analog the Kuroshio were found to meander along continuously changing paths, shedding eddies along the way (Fig. 5). Although such structures were discovered from multi-ship surveys, they had to await satellite photography and radar altimetry in the 1970s to be fully revealed. The utility of ship-based and mooring observations programs, designed to observe this "eddy variability", has been greatly enhanced by the knowledge gained from synoptic satellite imagery.

While flow variability decreases in intensity eastwards, as does the mean flow speed, the relative variability continues to be important. The drift of freely flowing buoys across the ocean shows a net eastward trend. Near the eastern coast, the variability may be such that the concept of a mean current becomes almost irrelevant, even below the direct layer of wind influence (Fig. 6).

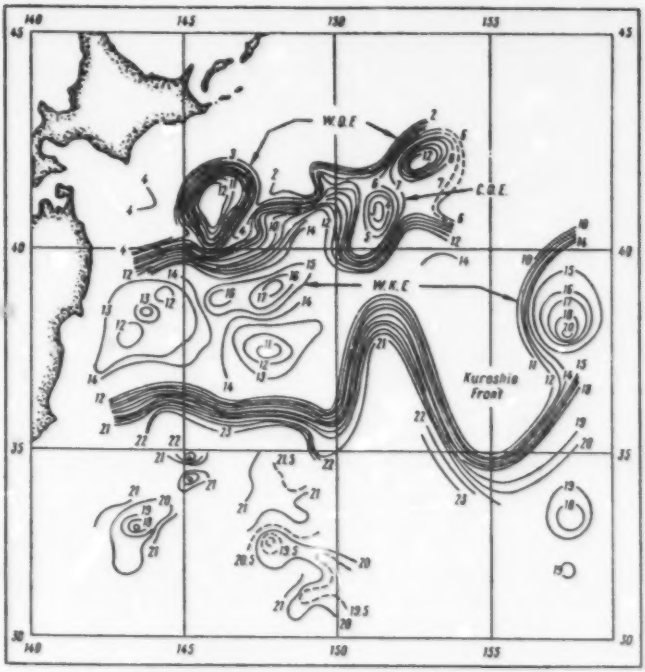

Figure 5. Eddies and meanders in the Kuroshio/Oyashio confluence region, as revealed by surface isotherms (temperature in degrees Celsius). The abbreviations refer to Warm Kuroshio, Warm Oyashio and Cold Oyashio Eddies respectively (from Cheney 1977). Such structures drift and change on a time scale of a few days.

The ocean is as variable as the atmosphere... even the deep ocean! One cannot rely on simple-minded maps of ocean currents for anything more than a vague qualitative picture. For a quantitative understanding, it is essential to characterize the variability. For example, the gradual intermixing of the warm Kuroshio and the cold Oyashio into the North Pacific Drift with gradually shifting north-south temperatures is the result of vigorous meandering and eddy shedding processes. The extremely large effective turbulent viscosities which one estimates from drifter paths such as those of Figure 6, or from numerical modelling, are a consequence of this large-scale agitation. The ocean is not easier to predict than the atmosphere! As a matter of fact, the situation is actually worse, because the horizontal scale of variability in the oceans is at least ten times smaller than in the atmosphere. Oceanic mesoscale eddies are only about 100 kilometres across; their atmospheric analogs, the large scale weather systems, are about 1,000 kilometres across. There is thus room for more eddies in the ocean than weather systems in the atmosphere, which makes the ocean a dynamically more complicated environment.

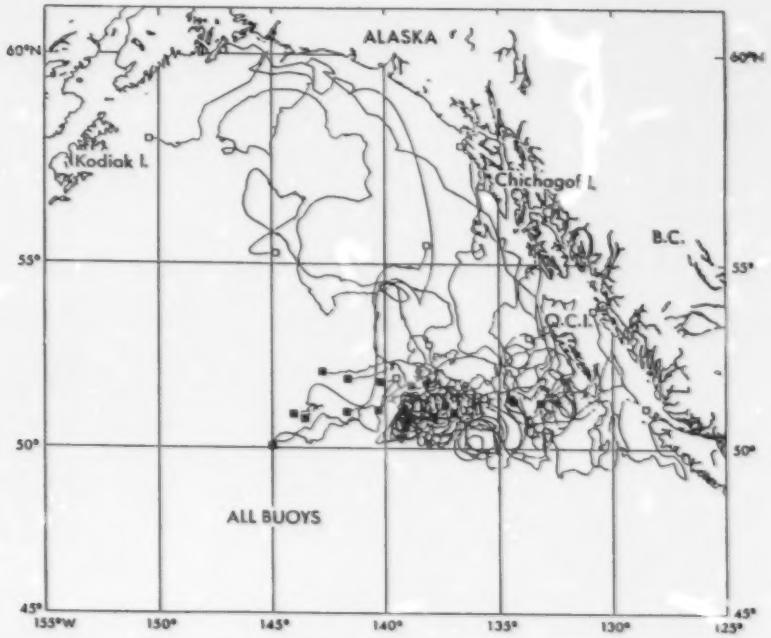

Figure 6. The paths of freely drifting buoys, attached to drogues below the level of the thermocline (approx. 100 m), released (at the location of the heavy squares) in the Northeast Pacific in June and October 1987. Trajectories cover a period of many months. A detailed examination of individual paths reveals the presence of many eddies, meanders and counter currents in directions opposite to the general picture seen in Figure 2. (from Thomson, LeBlond and Emery 1990).

Why is this a problem? Why can't annual averages be used for long-term phenomena? That would certainly be acceptable, as long as one did not wish to know anything on a time scale shorter than a year, such as this fall's salmon migration paths, or the severity of next winter's weather. Even then, one must realize that there is a lot of interannual variability (not every year is the same) and that enough information must be available on the nature of this variability to come up with the "average year". For example, the strength of the North Pacific Drift, and the latitude at which that current splits into the northward Alaska Current and the southward California Current changes from year to year. This means that one must sample the ocean variability for many years before obtaining statistically reliable estimates (Flierl and McWilliams 1977). Furthermore, having become more conscious of climate change in the past years, we now realize that the ocean is probably not in a statistically stationary state, so that present and future views of the ocean might not be equivalent to those so painstakingly documented by past measurements. This is all rather discouraging!

FUTURE PROSPECTS

What can be done? This whole question has been debated at length by people who have asked about the influence of the ocean on climate, and more specifically about the ocean's contribution to poleward heat transport. A massive international program, the World Ocean Circulation Experiment (WOCE) is now underway to answer this question. We have noted that eddy shedding and meandering appear to be important processes in smoothing out the north-south temperature gradient in the North Pacific. This is also the case in other parts of the ocean. Even with satellite monitoring, it is impractical to examine all the details of ocean eddy motion on a global scale. Plans for WOCE include a combination of observations and numerical modelling. It is the joint effort of both approaches, observation and modelling, which promises to resolve the conundrum and to allow satisfactory estimates of oceanic heat fluxes, based on incomplete observations supplemented by the laws of physics. Some of the observations and modelling for WOCE will take place in the North Pacific, as Canada's contribution to that program (LeBlond 1990). In the wake of WOCE, one may expect a sharply enhanced appreciation of large-scale variability and diffusion in the oceans, with application to our understanding of what happens in the North Pacific.

BIBLIOGRAPHY

Broecker, W.S., and Peng, T.-H., *Tracers in the Sea*. Lamont Doherty Geological Observatory, Columbia University, Palisades, N.Y., 1982.

Cheney, R.E., Synoptic observations of the oceanic frontal system east of Japan. *J. Geophys. Res.*, 82, (34) 1977. pp. 5459-5468.

Duxbury, A.C. and Duxbury, A., *The World's Oceans*. 2nd Ed. Dubuque, Iowa: W.C. Brown, 1989. 408 p.

Flierl, G.R. and McWilliams, J.C., On the sampling requirements for measuring moments of eddy variability. *J. Marine Res.*, 35, 1977. pp. 797-820.

LeBlond, P.H., What's WOCE. *Can. Meteo. & Oceanog. Soc. Newsletter*, 18, No. 2., 1990. pp. 4-6

Munk, W.M., Closing remarks at Monterey. *Oceanography*, 2, No. 2, 1989. p. 57

Reid, J.L., Intermediate waters of the Pacific Ocean. *The Johns Hopkins Oceanographic Studies*, No. 2. Baltimore: The Johns Hopkins Press, 1965.

Robinson, A.R., (ed.), *Wind-driven Ocean Circulation*. New York: Blaisdell, 1963. 161 p.

Stommel, H., The westward intensification of wind-driven currents. *Trans. Amer. Geophys. Union*, 29, 1948. pp. 202-206.

Stommel, H., and Yoshida, K., (eds.), *Kuroshio: Physical Aspects of the Japan Current*. Seattle: University Washington Press, 1972. 517 p.

Tabata, S., The general circulation of the Pacific Ocean and a brief account of the oceanographic structure of the North Pacific Ocean. Part I — Circulation and volume transports. *Atmosphere*, 13, 1975. pp. 133-168.

Tabata, S., The general circulation of the Pacific Ocean and a brief account of the oceanographic structure of the North Pacific Ocean. Part II — Thermal regime and influence on climate. *Atmosphere*, 14, 1976. pp. 1-27.

Thomson, R.E., Oceanography of the British Columbia Coast. *Can. Spec. Publ. Fish. Aquat. Sci.* 56, 1981. 291 pp.

Thomson, R.E.; LeBlond, P.H.; and Emery, W.J., Analysis of deep-drogued satellite-tracked drifter measurements in the Northeast Pacific. *Atmosphere-Ocean*, 28, 1990. pp. 409-443.

Willebrand, J. and Anderson, D.L.T. (eds.), Large-scale Transport Processes in Oceans and Atmosphere. *NATO ASI Series C*, 190. Dordrecht: Reidel Publ. Co. 1985. 379 p.

PETER A. LARKIN, F.R.S.C.*

Fisheries Resources of the North Pacific Ocean†

INTRODUCTION

It is one thing to speak of the populations of invertebrates, fish and mammals that inhabit the North Pacific Ocean and the adjacent seas, but quite another to speak of the fisheries resources of the region. The resources are the populations that have been or might be harvested for human use. Which populations those are depends not only on their abundance and catchability, but as well on the social and economic circumstances and cultural traditions of the fishing nations. Therein lies the major difference in what has and will constitute the fisheries resources of the various regions of the North Pacific Ocean. On the Asian side, there is a long history of fishing for a very wide range of species along a highly productive coastline. On the North American side, many fewer species are fished commercially and, except for the Bering Sea, productivity is generally lower than on the Asian side.

In the discussion that follows, for each of several regions there is given a brief account of the present and possible future production of organisms that are presently harvested, and some that are not presently harvested but which might be in the future. In preparing these remarks I have relied heavily on seven sources: (1) the reviews of Kasahara (1961, 1964) of the fisheries resources of the north Pacific; (2) the review of Larkin and Ricker (1964) of Canada's Pacific marine fisheries; (3) the review of Alverson *et al* (1964) of demersal fishes and fisheries of the Northeast Pacific; (4) the compilation of Gulland (1970) of the fish resources of the world's oceans; (5) the bulletins and statistical yearbooks of the International North Pacific Fisheries Commission; (6) the statistics of the FAO yearbooks and (7) the recent review of Ware and McFarlane (1989).

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The descriptive oceanography of the North Pacific has been dealt with by Paul LeBlond. As he has indicated, the physical circulation is the determinant of nutrient cycling which in turn is the determinant of the trophic processes which culminate in the production of organisms that can be used by humans. Where there is fertilizer there is grass and herbivores and carnivores. It is thus not to be wondered at that the areas of greatest fish production and harvest in large measure coincide with the areas where circulation favours high primary production.

The various species of fish in which this productivity is focused for human consumption are each adapted to perform most effectively within a limited range of temperature, so that in the North Pacific three large assemblages are readily distinguished: Subarctic species which inhabit the Bering Sea and Western Alaska, the Sea of Okhotsk and northern Japanese waters, where temperatures range up to roughly 10°C; Transition zone species which prefer temperatures of 10°C — 20°C, a zone which is narrower on the Asian side because of the greater compression of temperature isotherms in winter; Central Pacific species which occur where temperatures range from 18°C — 30°C. Within each of these three broad zones, assemblages of species may be distinguished as being pelagic, demersal or littoral (Table 1). For the demersal species a major constraint on abundance is the extent of the continental shelves where depths are less than 500 m. I will confine my remarks to the fisheries of the Subarctic and Transitional Zones.

There are a few major exceptions to the general rule that fish are caught where production is fostered by oceanic circulation. Highly migratory species may be caught far from their feeding grounds. For example, the migrations of Pacific Salmon (*Oncorhynchus* spp.) which constitute one of the great natural spectacles in the world, bring the plankton production of large tracts of the North Pacific to fisheries that, for the most part, are conducted close to shore. Another example is the long distance migration of whales which range far afield. Many other species of fish and mammals undertake migrations during the course of their life histories, but for the most part they are confined to seasonal north-south or inshore-offshore movements on a scale that ensures that they are caught close to the oceanic regions in which they are nurtured.

Because salmon constitute such a special case I shall treat them first, then turn to a brief discussion of a few species that wander widely in the Pacific, before dealing with the many other species that provide the bulk of present day catches in coastal waters.

PACIFIC SALMON & OTHER WANDERERS

Five species of Pacific salmon dominate the salmonid populations of the North Pacific, pink (*Oncorhynchus gorbuscha*), sockeye (*O. nerka*), chum (*O. keta*), coho (*O. kitsutch*) and chinook (*O. tschawytscha*). Each species is represented by several thousand discrete stocks each of which employs a particular freshwater stream for spawning. The homing of fish to their natal stream is not perfect but strays are relatively rare. On the North American side, chinook

Table 1. Typical commercial species of pelagic, demersal and littoral marine organisms in three broad regions of the North and Central Pacific Ocean.

	SUBARCTIC	TRANSITION	CENTRAL
Pelagic	Pollock	Sardine	Tuna
	Salmon	Squid	
	Herring	Saury	Marlin
Demersal	Yellowfin Sole	Halibut	Croakers
	Cod		
	King Crab	Dungeness Crab	Breams
Littoral	Sea Otter	Oysters	Coral Reef Fishes
	Seaweeds	Seaweeds	Milkfish

salmon occur from Northern California to the Mackenzie River in the Arctic but the other species have a narrower range. On the Asian side, salmon are found from the northern end of the island of Honshu to the Chukchi sea. The west coast of Kamchatka is a particularly rich source of pink salmon. The Bolshaya River alone had returns of over 50 million pink salmon in the peak years of abundance.

After entering salt water, the marine migrations of salmon may take them well past the midway point of the North Pacific (Figs. 1 to 3), crossing many oceanic domains en route and posing, incidentally, some fascinating questions about how they navigate to return to their stream of origin.

The total annual catch of salmon from the North Pacific was of the order of 300 million fish (750,000 tonnes) in the late 1920s and early 1930s, fell to roughly 220 million fish (400,000 tonnes) by the late 1960s and has since come back to approximately 300 million (Fig. 4). The recovery was principally on the North American side. In the decade 1927-36, the Asian side produced

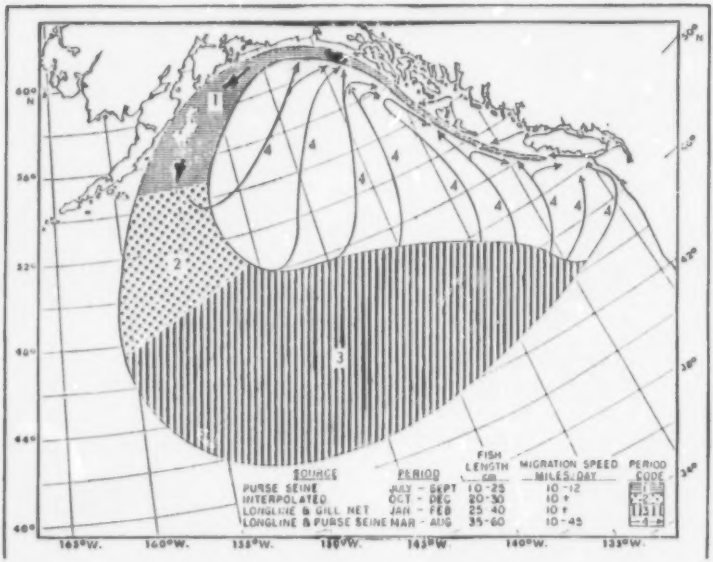

Figure 1. Schematic diagram of ocean migrations of pink salmon stocks originating in southeastern Alaska and British Columbia. From: Royce *et al.* 1968.

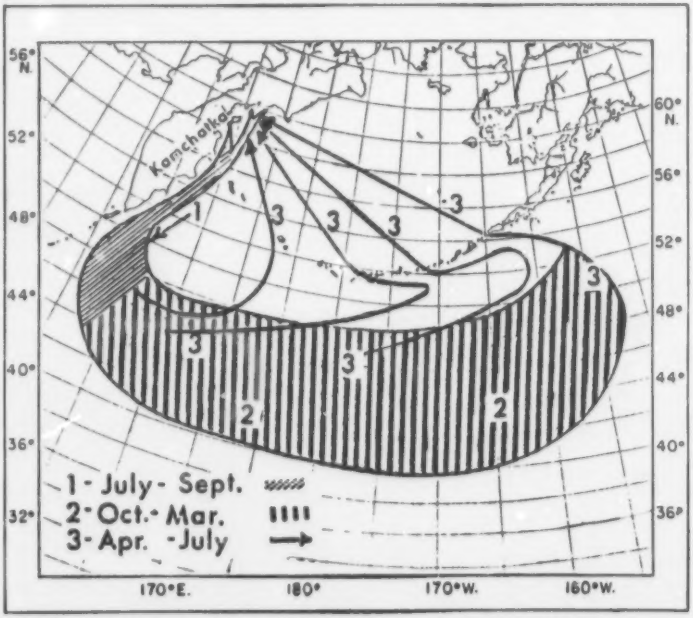

Figure 2. Schematic diagram of probable ocean migrations of pink salmon stocks originating in East Kamchatka. From: Royce *et al.* 1968.

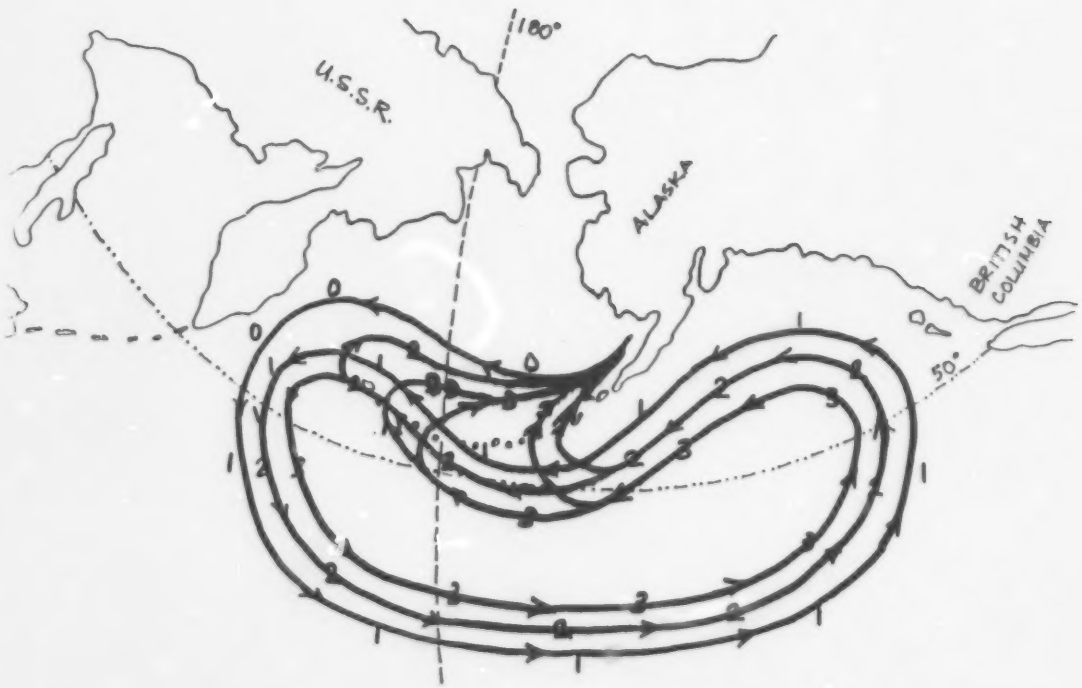

Figure 3. Diagram representing ocean migrations of Bristol Bay sockeye salmon, adapted from Royce *et al* (1968).

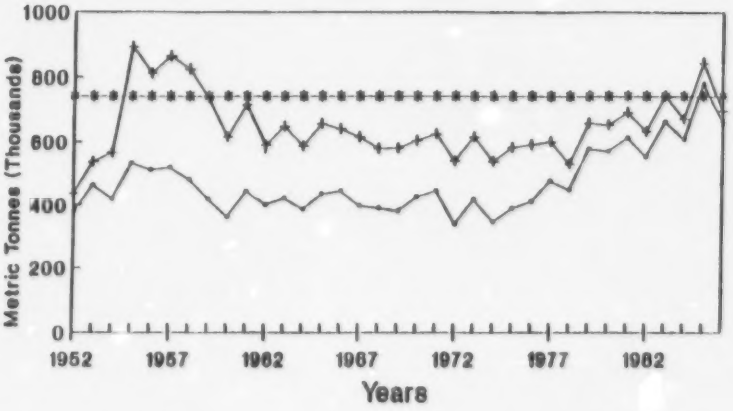

Figure 4. Catch of Pacific salmon, all nations, 1952-1986. Line joining dots gives landed weight. Line joining plus signs gives weight if fish had been caught at maturity rather than on the high seas. Line joining asterisks gives mean weight of catch for 1927-36.

60 per cent of the total catch, but for 1977-86 the catch was 60 per cent on the North American side (Fig. 5). By species, pink & chum are most abundant, particularly on the Asian side, sockeye are next most abundant and are more abundant on the north American side. Coho and chinook are the least numerous of the five species (Fig. 6).

It is important in comparing catch from different years to appreciate that there are strong cyclical fluctuations in the abundance of the various species, particularly pink and sockeye. Pink salmon have an almost invariable two-year life span so that the populations in even and odd years are virtually isolated. Over a long period of years, one population (say that in the odd years) will be numerically far more abundant than the other (i.e. that in the even years). For example, there are very, very few even-year fish in southern British Columbia, but the odd year runs may number many millions. Switches from odd to even year dominance (and vice versa) have been recorded on both sides of the Pacific and their causes remain a mystery (Ricker 1962).

Some sockeye salmon populations show strong cyclical fluctuations, in some instances seemingly synchronized in several tributaries of the same watershed. The Fraser River sockeye populations have a four-year cycle currently dominated by the Adams River stock on the even years not divisible by four (i.e. 1986-1990-1994). The largest sockeye populations of the North Pacific occur in the Bristol Bay region of Alaska which historically have shown a five-year cyclical fluctuation with some irregularities, particularly in recent years. For neither the Fraser nor the Bristol Bay populations has there been a satisfactory explanation for the cyclical pattern of abundance although there are several theories. The subject remains a rich field for basic research in population behaviour.

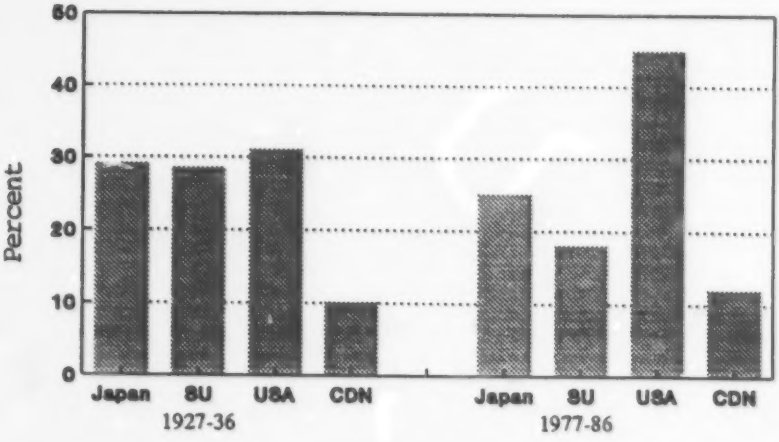

Figure 5. Percentage of total landed weight of catch of salmon by Japan, Soviet Union, United States and Canada 1927-36 and 1977-86.

The increase in the catch of salmon over the past fifteen years has come about in response to three factors. First, management has been much improved largely as a result of research findings. Over the period 1930 to 1965 there was overexploitation of many stocks. Asian stocks of pink, chum and sockeye were hard hit by Japanese and Russian coastal fisheries. Alaskan and British Columbian stocks were perhaps not as seriously depleted but management was not highly sophisticated. Since that time, management of salmon fisheries has become increasingly focused on individual stocks, for each, harvesting only those that are surplus to the optimum number for spawning in the home stream. A major problem arises from the harvesting of more than one species or stock at a time. Nevertheless, improved management has resulted in sustained production, particularly on the North American side.

Prior to 1950, little was known about the oceanic migrations of salmon and much of what is now known can be traced to the research activities carried out by Japan, Canada and the United States under the terms of the International North Pacific Fisheries Treaty. Because salmon from the Asian side come well across to the North American side the case could be made that North American fisherman could, if they wished, catch Asian salmon on the high seas in the eastern Pacific. Japanese fishermen had a similar kind of opportunity. They could catch fish of North American origin on the western side of the Pacific. By this logic, a dividing line would be equitable if it placed equal numbers of fish from each side at the disposal of fishermen from the other side. Virtually all of the fish that would be offered by Japan in such a proposal would be fish that originated in the streams of the U.S.S.R. and for which Japan annually negotiated a catch quota.

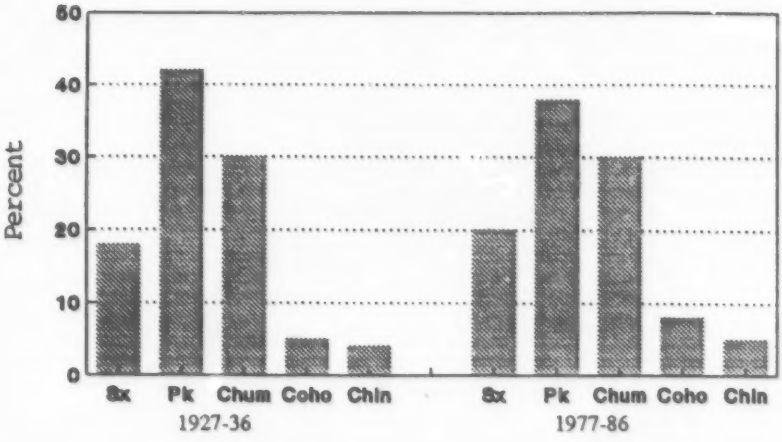

Figure 6. Percentage of total landed catch of various species of Pacific salmon 1927-36 and 1977-86. Sx=sockeye, Pk=pink, Chin=chinook.

This kind of proposal was unacceptable to the United States and Canada because it meant harvesting of various stocks of various species mixed together on the high seas, contrary to the prevailing management paradigm that rates of exploitation should be different for the various stocks and species. With the adoption of 200 mile exclusive economic zones much of the problem disappeared, largely because of the critical location and distances between the Aleutian islands. There was also widespread international acceptance of the notion that anadromous fish belonged to the nation of their stream of origin, a principle that has been the cornerstone of the Canadian position in negotiations with the United States on the subject of "each others' fish".

The second reason for increased catches has been the combined effect of conservation measures that are in part protective of natural environments and in part aimed at increasing production by enhancement measures. In 1987, for example, more than 4.5 billion young salmon were released from hatchery operations around the North Pacific (Table 2). The most spectacular results are those of the Japanese hatcheries for chum salmon which have doubled the Japanese catch of 25 million fish of the 1970s (much or most of which was fish of U.S.S.R. origin).

The results from pink salmon hatcheries in Central Alaska have also been impressive and have contributed perhaps as much as 25 million fish to the catch. In British Columbia, the combination of protection of salmon-producing streams and enhancement measures has to date been effective in stemming a long-term decline in abundance. There continue to be concerns especially for chinook salmon (and steelhead trout, (*Oncorhynchus mykiss*) which are naturally much less abundant and vulnerable to overexploitation incidental to

Table 2. Releases in 1987 of young Pacific salmon from hatcheries bordering the North Pacific (millions). (Data provided by G. Jones, British Columbia Packers Ltd.)

	Sockeye	Pink	Chum	Coho	Chinook	Total
United States:						
Alaska	58	459	299	16	9	841
Stateside	+	-	94	117	309	520
Canada[1]	247	16	199	22	55	539
USSR[2]	-	400	245	2	3	650
Japan[3]	+	125	2,000	-	-	2,125
Total	305	1,000	2,837	157	376	4,675

1. Does not include increased production from lake fertilization
2. Does not include lake fertilization nor release of *O. masu*
3. Does not include 14 million *O. masu*

the fishery on the abundant species. Much the same story can be told of the salmon resources of Washington, Oregon and Northern California.

The third factor influencing abundance of salmon and perhaps of other fishes is possible changes in ocean circulation. Although they are incompletely documented, there appear to be warming trends that have increased production, particularly in the northern parts of the North Pacific. These changes may simply be long-term fluctuations such as seem to have occurred over the last hundreds and thousands of years or they may reflect global warming trends. Either way they could have potentially large effects on salmon abundance.

Meanwhile, there is every prospect of increased production of salmon in fish farming operations and British Columbia fish farms are now growing over 10,000 tonnes of salmon per year, which is more than 10 per cent by weight of the wild catch. As demand grows there is a potential for substantial increases in production, especially in the southern part of the coast.

So much for the salmon resource of the North Pacific. There are some other species that are found over almost the same wide range, but at present are of little commercial significance. For example, the pomfret (*Brama rayii*) overlaps the distribution of the southern part of the range of salmon. Lantern fishes (Myctophidae) occur throughout the central reaches but have not been seen to be of commercial value despite their great abundance. In recent years, drift net fishing for squid (*Ommastrephes*) has taken a number of other species, ostensibly as bycatches, but which are as dead as they would be if taken intentionally.

Concern about the drift net fishery has focused chiefly on catches of salmon, but there is also perhaps reason for implicating drift net fishing in the decreased survival of the fur seal (*Callorhinus ursinus*) in recent years. Although they go ashore to breed on the Pribilof Islands on the North American side and the Robben and Commander Islands on the Asian side, they spend the remainder of the year at sea. Overexploited during the early Russian occupation of the North Pacific, the herds recovered only to be overexploited again in the latter part of the nineteenth century, largely through pelagic sealing which was subsequently outlawed in 1911 by an international convention signed by Great Britain (for Canada), Japan, the United States and Russia. Restricting the size of the harvest and taking only males led to an increase of the Pribilof herds to historic levels exceeding 1.5 million by the mid 1950s. Since that time the herds have been in decline, at first attributed to extending the harvest to females, then to the possible impact of commercial fisheries on the abundance of fish for food, and most recently on losses at sea from drift net fishing, ghost fishing of lost nets and other such marine hazards.

The other great wanderers of the North Pacific that early attracted the attention of man were the whales. Right whales (*Balaena glacialis*) and grey whales (*Eschrichtius gibbosus* were almost rendered extinct in the Pacific in the nineteenth century. Blue whales (*Balaenoptera musculus*), humpback whales (*Megaptera novaeangliae*) and sperm whales (*Physeter catodon*) were also heavily exploited. Fin whales (*Balaenoptera physalus*) and sei whales (*Balaenoptera borealis*) were taken but not in such large numbers. With the regulation of whaling by the International Whaling Convention of 1946, stocks of all species began to recover, and in recent years whaling has been further reduced in response to international public opinion.

THE ASIAN FISHERIES

There is a long history of fisheries off the coast of Asia, particularly of Japan and Korea. For example, the herring fishery of Hokkaido dates from the fifteenth century. The proximity of the Asian coast to areas of high biological production has ensured a sustained interest in the sea as a source of food. Near shore fishing rights have long been jealously guarded and closely controlled by prefectural administrations. In the latter part of the nineteenth century and the early part of the twentieth century the increased range of steam powered fishing vessels led to the rapid expansion of fishing activities much further offshore. Japanese fishermen ranged increasingly into waters off the coast of U.S.S.R. to the north and to the coasts of Korea and China to the west, successively exploiting new stocks. The U.S.S.R. was much less active in most fisheries until the 1930s, but after World War II became a major fisheries nation in most of the world's oceans, including the North Pacific.

The principal fisheries for pelagic species, aside from salmon, have been those for herring, sardines, anchovies, mackerel, saury and squid. Herring (*Clupea pallasi*) spawn in shallow waters from the Arctic to the east coast of Korea and show spectacular fluctuations in abundance which are related to the

success of particular year classes, such as that of the Hokkaido herring year class of 1939. With the passage of that year class, the herring fishery of Hokkaido and South Sakhalin declined from 750,000 tonnes to very low levels. A similar decline from great abundance occurred in the fishery for sardines (*Sardinops* spp.). Sharp fluctuations in sardine abundance had been reported many times in Japan: periods of great abundance occurred from 1570-1580, 1690-1720, 1800-1830 and 1929-1939. In the period 1934-39 the annual Asian catch, principally taken in the waters of Japan and Korea, reached 2.5 million tonnes but fell thereafter to only 250,000 tonnes. In the mid 1960s the catch was only 10,000 tonnes. Most recently, sardine catches have again been huge (5 million tonnes in 1984!). Anchovy (*Engraulis japonica*) catches have tended to increase as sardine catches declined and have reached over 400,000 tonnes. Mackerel (*Scomber japonicus*) are also concentrated in waters adjacent to Japan and Korea and annual catches have reached 500,000 tonnes.

Pacific saury (*Cololabis saira*) are distributed from the coast to far offshore in the transition zone and are much less subject to fluctuations in abundance. Together with squid (*Todarodes pacificus*) they constitute an important fishery that may produce a million tonnes per year. The squid fishery grew very rapidly in the 1950s and 1960s, with sharp fluctuations in abundance and catchability apparently tied to interannual differences in upwellings and convergences.

These pelagic species, together with several others of lesser significance, such as jack mackerel (*Trachurus japonicus*) and yellowtail (*Seriola quinqueradiata*) are influenced by common or interrelated oceanographic conditions and to various degrees share common food resources. In consequence, a fishery on one species may influence the abundance of others and changes in oceanographic regions may differentially influence year class success. The unravelling of the causes of the fluctuations in abundance, and in particular whether the fisheries have been instrumental in declines of stocks has been a continuing source of controversy.

A major pelagic fishery in recent years has been that for the Alaska pollock (*Theragra chalcogrammus*), one of the most widely distributed and most abundant fish species of the North Pacific. Although it is a subarctic species it occurs at greater depths in the transition zone at high levels of abundance. Historically, the fishery was concentrated near Korea where the annual harvest in the 1930s was of the order of 300,000 tonnes. The Japanese catch grew steadily through the 1950s and by the mid 1960s the catch by all nations in the Sea of Japan reached 600,000 tonnes at full exploitation. The fishery then moved further afield. Over 200,000 tonnes was taken annually from the Sea of Okhotsk, a further 200,000 tonnes off the Pacific coasts of Japan and Kamchatka in the late 1960s. The fishery then moved on to the Eastern Bering Sea with both Japan and the U.S.S.R. fleets actively involved. In 1986, pollock led the world list of fish production with a total harvest of 6.7 million tonnes.

The progressive exploitation of stocks across the Pacific from the Asian side also occurred for the demersal species, Pacific cod, various northern flatfishes and King crabs. Pacific cod (*Gadus macrocephalus*) occur widely in the North Pacific and adjacent seas as a number of fairly discrete stocks

whose seasonal movements in northern waters are limited by the occurrence of water temperatures below 0°C. Japanese cod catches in Asian waters approximate 60,000 tonnes per year and the U.S.S.R. catch from local waters has grown in recent years to a similar magnitude.

The various flatfishes of the North Pacific are spread over both the subarctic and transition zones and are highly prized as food fishes. The catch is concentrated in northern areas and as southern stocks became overexploited, the familiar pattern unfolded of northern and eastern movement of the fishing fleets. The combined Japanese and U.S.S.R. catch of flatfish approximated 50,000 tonnes in the early 1950s. By the end of the decade the catch had leapt to 300,000 tonnes, chiefly on the basis of catches in the eastern Bering Sea and it continued to increase thereafter. The species of greatest commercial significance were yellowfin sole (*Limanda aspera*), rock sole (*Lepidossetta bilineata*) and turbot (*Atheresthes stomias*).

The King crab (*Paralithodes camtschatika*) and tanner crab (*Chionocetes opilio*) are highly valuable species that were heavily exploited on the Asian continental shelf before the fishery moved to waters off the Alaska coast and the Eastern Bering Sea in the post war period. King crab exhibit extraordinary aggregative reproductive behaviour which makes them particularly vulnerable to exploitation. In addition, recruitment is apparently highly dependent on the vicissitudes of oceanographic circulation. Peak annual catches on the Asian side were of the order of 20 million crabs in the 1930s.

To summarize, the fisheries resources of the Asian side of the North Pacific are substantial and have been heavily exploited throughout the twentieth century. As the range of fishing vessels increased, stocks were exploited further to the north and further offshore until in the 1960s there was heavy fishing on the high seas and off the coast of North America. The total catch from the northwest Pacific approximates 7 million tonnes per year, roughly 10 per cent of the world's catch and at its upper limit of sustainable total production.

BERING SEA FISHERIES

As the Asian fisheries moved north and east they encountered stocks that were resident in waters close to the North American coast, leading to the enunciation by the United States of the "principle of abstention", which stated that other nations should abstain from fishing on stocks that were being managed to produce a maximum sustained yield. The species of greatest concern at the time (1955) were salmon, halibut and king crab, but the subsequent development of fisheries for other species led to more general concerns. With the setting of 200 mile zones in 1974 the eastern Bering Sea fisheries came under United States control. Since that time fishing by foreign fleets has been under license and has increasingly been based on joint ventures with United States partners.

The total catch from the eastern Bering Sea is currently in the vicinity of 2 million tonnes per year and is dominated by yellowfin sole, pollock and

Pacific cod. Extensive surveys of resources before exploitation became heavy have enabled estimates of the standing stocks and hence of the sustainable yield. On this basis, the present total yield is close to or slightly in excess of that which is sustainable.

The king crab concentrations in the eastern Bering Sea were located by Japanese fishermen shortly before World War II. After the war the fishery by both Japan and the U.S.S.R. developed rapidly with reported catches of 5 million crabs. Negotiations with the United States led to the phasing out of the foreign fleets and since the early 1970s the fishery has been exclusively by United States fishermen. Catches rose to a peak of 20 million in 1980, but thereafter declined to very low levels.

For both the demersal fisheries and the king crab fisheries the control by a single nation has not meant that management became blissful. Attracted by the great potentials, the industry rapidly became overcapitalized placing great pressures on management to maintain the highest possible catches. Aside from the economic inefficiency that bedevils open access fisheries world-wide, there were many undesirable side effects including large losses from discarded bycatches, ghost fishing by lost gear, short intense fishing seasons with their attendant problems of allocating catch and enforcement of regulations, greater costs of processing and poorer quality products. The Bering Sea fisheries are the latest unfolding of a scenario that has been repeated many times in the past century.

NORTH AMERICAN FISHERIES

Fisheries on the North American side have been on a much smaller scale than those of the Asian side. Except for the Bering Sea there are few areas of continental shelf of depth less than 500 m. Aside from salmon, well-established fisheries are those for herring and sardines (prior to 1950), hake, pollock, cod, sablefish, ocean perch and halibut.

The herring fisheries of British Columbia began in 1877, expanded after the turn of the century to supply an oriental market for dry-salt herring and when that market declined, expanded still further as a fishery for oil and meal. During the 1950s catches averaged close to 165,000 tonnes. In the 1960s the fishery collapsed, probably as a result of overexploitation. It has subsequently recovered and the stocks are now fished primarily for roe at a stable yield of about 30,000 tonnes. An additional 20,000 tonnes are produced in Alaska.

Sardines were first harvested in British Columbia in 1917 as pilchards and by the early 1930s an important industry had developed. The pilchards were the northernmost older aged component of a large stock that extended to Baja California and which supported a large fishery based in California. The B.C. pilchard fishery averaged 50,000 tonnes per year in the early 1940s and then collapsed. The peak catch in California was 700,000 tonnes in 1936, but after 1944 catches declined rapidly and by 1953 the sardine fishery was no more. The decline of the sardines was followed by an increase in abundance of anchovy (*Engraulis mordax*) in California waters. There has been little effort

to develop a fishery for anchovies anywhere along the North American coast though there is probably a potential for an annual catch of 750,000 tonnes.

A fishery for hake (*Merluccius productus*) from British Columbia south to the coastal shelf off Washinton and Oregon has developed over the past two decades, initially by foreign fleets and subsequently under licensing arrangements or joint ventures. The stocks are underexploited, producing 130,000 tonnes but with a sustainable capacity of 200,000 tonnes. There is also a substantial potential of perhaps as much as 200,000 tonnes in catches of jackmackerel (*Trachurus symmetricus*) off the coast from northern California to Southeast Alaska. To the north, the pollock (*Theragra chalcogrammus*) is the dominant mid-water roundfish and produces 200,000 tonnnes per year in Alaska.

Pacific cod (*Gadus macrocephalus*) supported a salt fish industry in the North Pacific in the late nineteenth century, but demand fell and the fishery remained small until the 1950s when it rose to between 5,000 and 10,000 tonnes. The present catch is roughly 30,000 tonnes, the potential is for 100,000 tonnes.

Sablefish (*Anoplopoma fimbria*) are well known locally in their smoked form as "Alaska blackcod". They occur along the coast from Oregon to western Alaska, their abundance increasing with depth out to the edge of the continental shelf. The present catch of 30,000 tonnes is probably less than the potential.

There are five common species of Pacific ocean perch of the genus *Sebastes* which occur along the coast from Oregon to the Alaska peninsula and are usually most abundant in deeper waters. The present catch is roughly 20,000 tonnes per year, a level which may not be sustainable for these very slow growing species. Foreign fleets first showed interest in these stocks in the 1960s but in recent years the imposition of 200 mile limits and licensing requirements have regulated removals.

The fishery for halibut (*Hippoglossus stenolepis*) of the Pacific Northwest is one of the classics of fisheries biology. A long line fishery began off the B.C. coast at the turn of the century and by 1930 extended from California to the Bering Sea. Catches peaked in 1915 at about 30,000 tonnes and the decline thereafter led in 1923 to the establishment of the first United States/Canada convention for fisheries conservation. Since that time the international commission set up by the convention has managed the fishery to ensure sustained production at a level of about 15,000 tonnes. This proved to be difficult when extensive trawling began in the Eastern Bering Sea and northern Alaska waters, taking halibut as bycatches to more abundant species.

The total catch along the North American coast, excluding the Bering Sea but including salmon is approximately 900,000 tonnes. The potential is over 2 million tonnes. The fishery for Dungeness crab (*Cancer magister*) is not large but has had some significant fluctuations, the cause of which remains to be discovered. Crabs are taken from California to Southeast Alaska. In northern California the total catch has a cyclical pattern with a period of roughly 10 years, ranging from lows of a few hundred thousand to peaks of 5 to 6 million (Botsford *et al* 1982). Similar but less pronounced fluctuations

occur in the more northerly part of the range. The total annual catch of crabs is not readily assessed because there is a substantial take for domestic and recreational purposes, but it is probably in excess of 20 million in good years.

DISCUSSION

The foregoing has briefly sketched the production of the major fisheries resources of the North Pacific Ocean. Much more could be written about the harvest of many species of fish of lesser commercial significance. Very much more could be written about the large harvests of invertebrates such as oysters, clams, shrimps and prawns and the many varieties of seaweeds that are taken for food. Much of this kind of production is now done using intensive methods of culture in privately owned or licensed nearshore waters.

The history of the North Pacific fisheries is in many respects a familiar story. The earliest fisheries were shore based, used primitive gear and harvested only those species that were relatively easily taken. The only species likely to be overharvested were those that were especially vulnerable, such as Pacific salmon, which came right to the traps of the fishermen. With the development of large vessels and more sophisticated gear, fishermen increasingly exploited stocks further offshore. The most vulnerable and most valuable species such as fur seals, sea otters, whales and salmon were the first to be harvested beyond their capacities to sustain yield, but even before the advent of steam powered vessels there were significant inroads on the stocks of many other species on the Asian side and of the most desired species on the North American side.

The turn of the century marked the major expansion of fisheries on both sides of the ocean. Japanese, and to some extent Korean, fishermen ventured further north and east beyond the productive fisheries of the northern end of the Sea of Japan to the Sea of Okhotsk and the Kamchatka peninsula. By the mid 1930s they had worked their way across the Bering Sea and were exploring the North American side. The U.S.S.R. meanwhile had been relatively inactive in high seas fisheries, the largest fisheries being confined to relatively near shore operations, with a substantial trap net fishery for salmon. On the North American side, the fishery took a much less varied array of species. Targeting on salmon, halibut and herring, there were soon seen to be signs of the effects of harvesting beyond the sustainable yields of some local stocks and conservation measures were put in place.

The difference in philosophy of fisheries management on the two sides of the ocean came clearly into focus shortly after World War II with Japanese catches of salmon on the high seas, and of king crab and groundfish off Alaska. On the Asian side, fluctuations in abundance were seen to be related in large part to oceanographic conditions and interactions between species, rather than to the effects of fishing. In any case, if a fishery declined, then one simply went to some other place or went after some other species. The North American management philosophy was rooted in the paradigm of maximum sustainable yield so it was not surprising that the abstention principle was the cornerstone of policy *vis-à-vis* the activities of foreign fleets.

By the early 1970s, far seas fishing fleets were active in almost all of the areas of major concentration of fish production in the world. In the North Pacific, the U.S.S.R. had joined Japan in trawling in the Bering Sea. Fishing vessels of countries other than the Americas were engaged in various kinds of fishing along most of the coastline from Tierra del Fuego to the Chukchi sea. World catch reached 70 million tonnes and there was widespread concern that the harvest of species of current commercial value was approaching its sustainable maximum. In this climate of opinion, consensus was reached among the nations of the world for the imposition of 200 mile limits, an arbitrary figure that does not make consistent sense for purposes of fisheries management but which nevertheless brought a substantial fraction of the world's fisheries under the control of the coastal states.

The era of 200 mile limits was launched with a flurry of bilateral agreements and joint ventures that more or less maintained the status quo. Subsequently, some nations have developed their own fisheries (often with foreign investment) and the foreign fleets have been phased out. One way and another the total world catch has been held at 1970 levels and augmented somewhat by the increased harvest of some stocks such as pollock in the Bering Sea, tunas world-wide, and Antarctic species, including krill (Table 3). The biggest increase in world production has come from aquaculture activities which tripled from about 5 million to 15 million tonnes over the past fifteen years and show promise of a further doubling over the next fifteen years.

There is still perhaps a little slack in the North Pacific potential for production of "wild" fish. Fisheries for pomfret, saury, and squid might better tap the total possible production from the central offshore regions, but it must be kept in mind that these are not highly productive parts of the ocean. Making a business of fishing there means technologies that can sweep large areas at low cost, such as by drift netting which may have serious side effects on other species such as salmon and marine mammals. It seems likely that to achieve the greatest volume of production it would be necessary to make sacrifices that are not at present acceptable, at least to North Americans. This is especially the case when it is perceived that it may be possible to further enhance production of salmon by hatchery and other techniques.

Closer to the coast there are large untapped potentials for the harvest of anchovies off the coast from Baja California to British Columbia, and some possibilities for increased harvests of hake, jack mackeral (*Trachurus symmetricus*) and cod.

Perhaps the best prospects for the future will come from aquaculture. As the economics of these operations become increasingly favourable with improved technologies of disease control, nutrition, genetics and containment, the parallels to the development of modern day agriculture are more and more evident (Larkin 1990). Aquacultural prospects for the North Pacific have been abundantly explored with traditional methods on the Asian coast, but there is still potential for greater production particularly on the coast of the U.S.S.R. On the North American side the major fish cultural enterprises historically were salmon hatcheries. After more than three-quarters of a century of trial

Table 3. World fish and shellfish production in 1970 and estimated for 1990 in millions of tons. Production of shrimps and shellfish includes aquaculture.

	1970	1990 (est.)
"Whitefish" (cods, hakes, haddocks, perches, basses, flounders, soles)	16	21
Pelagic fish (tunas, mackerels, billfishes, jacks, mullets, sauries)	9	15
Pelagic fish (herrings, sardines, anchovies)	22	24
Shellfish (oysters, mussels, scallops, clams)	2.2	4.2*
Shellfish (lobsters, crabs, squids)	1.8	2.8
Shrimps and prawns	1	2**
Other (includes all freshwater and aquaculture other than shrimps & shellfish)	18	31
Total	70	100

*Includes 0.3 from aquaculture
**Includes some aquaculture

and error they began to demonstrate their potential in the 1970s. Since that time, enhancement measures have contributed not only to the wild catch but also provided the infrastructure from which salmon farming was launched. The limiting factors for future development will be costs in the North Pacific in comparison to costs in other parts of the world where salmon are now raised. There can be little doubt though that in the long term, aquaculture will be a major fish producer on both sides of the North Pacific.

The great unknown for the future of North Pacific fisheries resources is the impact of global climatic change. In addition to the likelihood of warming of near shore bays and estuaries there may well be changes in ocean circulation on a major scale. If this should happen there could be shifts in the regions of upwelling and downwelling and in the areas of highest productivity. Some preliminary speculation has suggested possible increases in productivity off the North American coast, but what this may mean for the commercially important species is anybody's guess. Here on the British Columbia coast we

are at the dividing line of two major oceanic domains, close to the southern end of the range of some species (such as pink salmon), close to the northern end of other species (such as sardines), and there could well be some major changes in our fishing enterprise.

BIBLIOGRAPHY

Alverson, D.L.; Pruter, A.T.; and Ronholt, L.L., A study of demersal fishes and fisheries of the Northeastern Pacific Ocean. MacMillan lectures in fisheries. The University of British Columbia, 1964. 190 pp.

Alverson, Dayton L., (MS) Fisheries resources and management in the twenty-first century. Presentation at Ocean Agenda 21, Portland, Oregon.

Botsford, Louis W.; Methot, Jr., Richard D.; and Wilen, James E., Cyclic covariation in the California king salmon, *Oncorhynchus tschawytscha*, silver salmon, *O. kisutch*, and Dungeness crab, *Cancer magister* fisheries. *Fishery Bulletin*. 80 (4) 1982 pp. 791-801.

Food and Agricultural Organization of the United Nations, *Yearbooks of Fisheries Statistics 1954-1986*. Rome.

Gulland, J.A. (ed.), The fish resources of the ocean. *F.A.O. Fisheries Technical Paper 94*, 1970. 425 pp.

International North Pacific Fisheries Commission, *Bulletins* 1-48. Vancouver, Canada, 1955-1986.

International North Pacific Fisheries Commission 1972-1989. Statistical yearbooks for the years 1970 to 1986. Vancouver, Canada.

Kasahara, Hiroshi, Fisheries resources of the North Pacific ocean. Part I. H.R. MacMillan lectures in fisheries. The University of British Columbia, 1961. 135 pp.

————, Fisheries resources of the North Pacific ocean. Part II. H.R. MacMillan lectures in fisheries. The University of British Columbia, 1964.

Larkin, P.A., and Ricker, W.E., *Canada's Pacific marine fisheries: past performance and future prospects*. Proc. 15th B.C. Nat. Res. Conf., 1964. pp. 194-268.

Larkin, P.A., *Mariculture and Fisheries: Future Prospects and Partnerships*. Rapp. P-v Reun. Cons. perm. int. Explor. Mer. (in press).

Ricker, W.E., Regulation of the abundance of pink salmon populations. In N.J. Wilimovsky (ed.) Symposium on pink salmon. H.R. MacMillan Lectures in Fisheries. The University of British Columbia, 1962. pp. 155-201.

Royce, William F.; Smith, Lynwood S.; and Hartt, Allan C., Models of oceanic migrations of Pacific salmon and comments on guiding mechanisms. *Fishery Bulletin* 66 (3) 1968. pp. 441-462.

Ware, D.M., and McFarlane, G.A., Fisheries production domains in the Northeast Pacific Ocean. In R.I. Beamish and G.A. McFarlane (ed.), Effects of ocean variability on recruitment and an evaluation of parameters used in stock assessment models. *Can. Spec. Publ. Fish. Aquat. Sci.* 108, 1989. p. 359-379.

JOHN E. BARDACH*

Aquaculture and Food Opportunities and Constraints†

INTRODUCTION

Protein of aquatic provenance — mostly fish but also mollusks and crustaceans — makes up about one quarter of all animal products for human consumption (FAO 1987)[1]. The roughly 25 million metric tons of fish that are annually turned into fish meal and oil, primarily as ingredients for livestock feed and for feeds in aquaculture are left out of this comparison. The most important locations for aquaculture are China and tropical Asia (Tables 1 and 2). In terms of species groups finfish, primarily from freshwater locations, supply the largest amounts while molluscs are not far behind and crustaceans, though bringing up the rear, are gaining fast (Table 3). Seaweeds are important in supplying industrial colloids rather than food, even though they also play a role in the non-protein diet especially of East Asia. (They, and other products of aquaculture that are not eaten, such as pearls, will not be discussed in this article.)

In many regions of the sea the harvest of wild stocks of fishes and invertebrates are approaching sustainable yields and in others these yields have been exceeded and catches have declined. There are few stocks of marine foodfishes that are still amenable to increased sustainable exploitation and it is therefore logical to look to aquaculture to make up certain shortfalls. Expected population growth and economic development affording greater buying power and changes in diet make it clear that these shortfalls will increase and that incentives for aquaculture are growing. It is therefore germane to examine the likely course for aquaculture development into the 21st century from its present status, its applied scientific base, needs that can be seen for technical advances in its practices, and certain social and economic factors that may favour or hinder such development.

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Table 1. Summary of Aquaculture Production by Food and Agriculture Organization Regions (1983 data).

Regions	Finfish	Mollusks	Crustaceans (metric tons)	Seaweeds	Totals
Africa	43,553	286	26	—	49,865
Asia/Pacific	3,357,978	2,586,464	75,644	2,392,045	8,412,131
Europe/Near East	726,530	494,719	162	100	1,221,511
South America	167,797	30,883	20,188	1,637	220,505
North America	152,088	133,178	27,425	—	312,691
Totals	4,447,946	3,245,530	123,445	2,393,782	10,216,703

Source: C. Nash, "Aquaculture Attracts Increasing Share of Development Aid", *Fish Farming International*, June 1987, 21-24.

Table 3. Contributions from Aquaculture to the World Supply of Fisheries Products (1983 data)

Source	Finfish	Crustaceans (metric tons)	Mollusks	Seaweeds
Capture fisheries (less aquaculture)	62,753,000	3,069,000	878,000	811,000
Aquaculture fisheries	4,448,000	123,000	3,246,000	2,394,000
Percent share of aquaculture fisheries in world supply	7	4	72(59)*	75

*First number is shelled mollusks only, second all mollusks.

Source: C. Nash, "Aquaculture Attracts Increasing Share of Development Aid", *Fish Farming International*, June 1987, 21-24.

Table 2

IMPORTANCE OF FISH AND AQUACULTURE IN ASIAN NUTRITION

COUNTRY	1987 POPULATION (millions)	TOTAL FISH PRODUCTION (million metric tons)	FISH % ANIMAL PROTEIN	AQUACULTURE PRODUCTION (million metric tons)	AQUACULTURE % FISH PRODUCTION	AQUACULTURE % ANIMAL PROTEIN
Bangladesh	107.1	0.75	52.2	0.13	17	8.87
People's Republic of China	1,062.0	7.05	33.0	3.20	45	14.85
India	800.3	2.86	15.1	1.18	41	6.19
Indonesia	174.9	2.37	67.9	0.30	13	8.83
Malaysia	16.1	0.79	41.6	0.06	9	3.74
Nepal	17.8	0.0006	0.1	0.0004	67	0.07
Philippines	61.5	2.05	56.7	0.50	24	13.61
Sri Lanka	16.3	0.22	39.4	0.036	16	6.30
Thailand	53.6	2.23	51.5	0.14	6	3.09

SOURCES: Population Reference Bureau, Washington, D.C., 1987; Workshop on Socio Economics of Aquaculture, Bangkok, 1987; Food and Agriculture Organization, Rome, 1987; *GeoJournal* 10, no.3(1985), full issue.

CULTURE TECHNIQUES

Aquaculture can be done in fresh water or in various reaches of the sea near shore where it may be called mariculture (Fig. 1). It can be an intensive enterprise, with species raised in raceways and tanks or in floating cages. It can be extensive, demanding few continuous inputs of labour and relying on foods occurring in nature, as with reef farms or in stocked lakes. Farming of oysters and mussels also belongs in this category, although in some cases it requires substantial infrastructure, such as rafts, and much upkeep. Most aquaculture is of the semi-intensive kind where the juveniles are either caught in the wild or taken from hatcheries and where variable amounts of food are supplemented by the farmer.

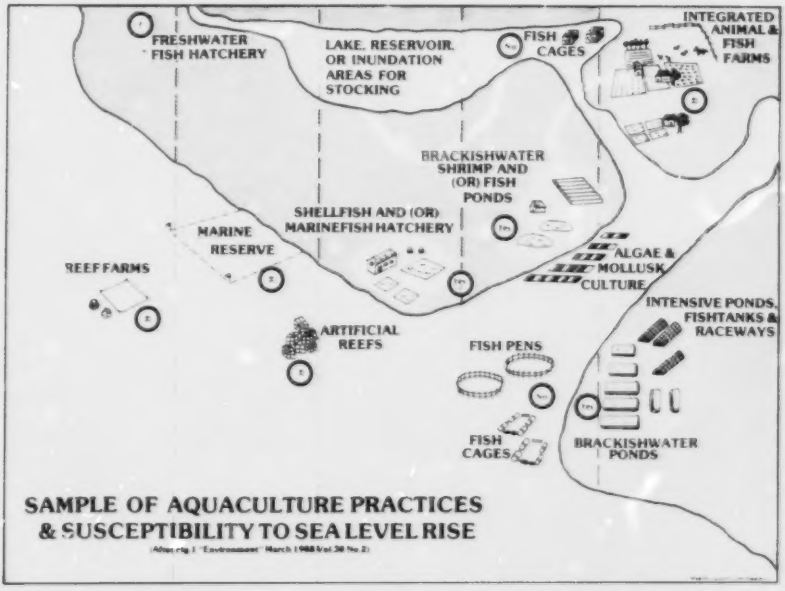

Figure 1. Sample of Aquaculture Practices and Susceptibility to Sea Level Rise
Source: after Fig. 1, *Environment*, March 1988, Vol. 30, No. 2.

Today's trend in aquaculture is toward intensification, striving to attain the total control over the life cycles of the cultivars that has been achieved in land animal husbandry. Simply put, this means attention to "breed" (genetic homogeneity and improvement); "seed" (requiring hatcheries that assure availability of larvae and juveniles that have high rates of survival); "feed" (the supply of nutritiously balanced and cheap rations); and "weed" (the gamut of control over disease and parasites primarily through the regulation of environmental variables such as temperature, oxygen content of the water, and salinity).

As techniques become more intensive and labour, material, and energy inputs rise, the ouputs rise, the output per unit of surface increases (Fig. 2) — up to a point, of course.[2] In the case of the presently most popular species, marine penaeid shrimp, the output may go from below a hundred kilograms per hectare in large coastal ponds to many tons per hectare.

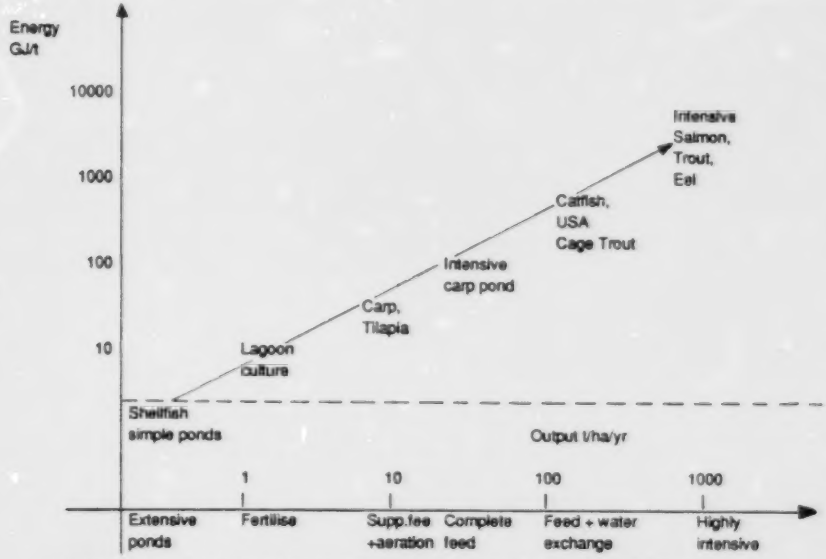

Figure 2. Relation of Energy/Material Inputs to Aquaculture Outputs
Source: after Muir 1985[18]

In mollusc culture, techniques range from the very simple practice of essentially policing tidal flats to providing complex attachment devices for the spat (larvae that settle out of the plankton and attach themselves to a substrate) that hang from movable rafts several meters down into the plankton-rich water, such as are used in Spain and Japan. Yields attained with these devices are among the highest achieved in mariculture.

In these and other extensive culture techniques for fish, crustaceans, or molluscs, control over breeding and seed production is not included, with reliance instead on the gathering of naturally occurring larvae or fry. The controlled breeding and rearing of larvae of aquatic animals can be difficult because the young stages are often very brief, and the eggs are often minute. Also the larvae may have different environmental requirements from the adults and the effects of multiple environmental variables such as day length, salinity, and temperature control on maturation are incompletely understood. Early advances in controlled fish breeding were made only where the eggs were relatively large and hardy, as in the case of salmon and trout, or where the eggs were deposited in clutches on aquatic vegetation and therefore readily

transportable, as in the case of common carp.[3] Marine species such as milkfish, which produce millions of tiny eggs, or mullet or oysters, with similarly microscopic offspring, are far more difficult to breed.

However hormone treatment by means of implanted pellets is now affording control over the spawning process, and better techniques of holding and feeding the tiny larvae both with live food (Artemia and Rotifers) or, in some cases with micro-encapsulation of adequate feed components, are pointing the way to better survival of certain marine animal larvae and fry. The spawning of oysters can be brought about by judicious combination of light regimes with treatment with chemicals.

Since control over the entire life cycle of some of the cultivar species has only recently been achieved, the application of modern genetics in aquaculture is barely beginning. One should add that dealing mostly with hidden, difficult to handle cultivars, compared to say chicken or pigs, breeding progenitors in traditional fish culture have mostly been selected by size; they are not necessarily the most fecund nor have they the best tasting flesh or greatest disease resistance. Isolation of single spawners is hardly practised outside of experimental situations but as all the skills of the terrestrial livestock breeder are applied to aquaculture; there will be selection for growth rate, fertility, taste of the flesh, color, and resistance to disease. The possibility to improve productivity in aquaculture by applying selective breeding and hybridization is very good. This is due particularly to large genetic variability in most economically important traits and high fecundity in species of interest. To increase efficiency, selection should be combined with family selection. It is concluded that if additive genetic variance is present in economically important traits, selection should be practised, and if non-additive genetic variance is considerable, selection should be combined with crossbreeding. It is recommended that breeding stations be established to carry out selection programs. Breeding programs need considerable investments and operating funds. However, they have been shown to produce very favourable benefit/cost relationships.[4] Controlled breeding, even paired with some achievement of genetic engineering, will transform aquaculture into a true food industry with a base in applied science.

SPECIES SELECTION AND FEEDING

The domestication of land animals and that of food plants went hand-in-hand and the kinds of domestic mammals and birds can be counted on the fingers of both hands; they were selected from the wild by man throughout the history of civilization from a total of roughly 8,600 avian and around 4,500 mammalian species. There are about 17,000 recent species of fish, some 35,000 kinds of crustaceans and even more molluscs to choose from for most suitable cultivars.[5] Let there be subtracted in the last two groups the many microscopic, the deep-sea or the very predaceous kinds, all unsuitable for rearing, there still remain among fishes and aquatic invertebrates many more kinds than among birds or mammals to serve as a basis for the development of domesticated

strains. It is not surprising, that a handbook on aquaculture[6], arranged by species rather than by methods has 40 different chapter headings while its index of plant and animal names (local ones included) lists about a thousand entries. Contrast with that plethora of choice the fact that early man could not transport fish or shellfish in his wandering while he could take pigs on canoes, as did the Polynesians in their voyage from island to island, and that fowl could well be carried in wicker cages even on horseback, as they still are in parts of the world today.

Early aquaculture was done with local species. Some of these have now spread worldwide, and become subject to full control over their life cycles, permitting, mainly during this century, incipient genetic improvement over wild congeners in such traits as better growth rates, desired colors rather than nature's protective one's, better dressout weights, bred-in disease resistance, etc.

Even though organisms grow faster in the tropics, the temperate zone common carp (*Cyprinus Carpio*) and various kinds of trout, mainly the rainbow one (*Salmo gairdnerii*) are now the prime examples of reasonably advanced domestication among fishes. Of all the species of fish utilized by man the common carp has the longest history of culture. As early as 475 B.C. spawning of captive carp in China was described and advocated as a profitable business by Fan Li in the first known treatise on aquaculture.[7] Some authors believe the practice dates back as far as 2000 B.C. Aristotle mentions carp, and it is likely that both the Greeks and Romans fattened carp in ponds. Further introductions in Europe may have taken place around 1150 and they have now been introduced to the remaining continents.

Several other species in the same family as the carp, the minnow family (*Cyprinidae*), are also near-domesticated and have now become fairly widespread. These are mainly the so-called Chinese but also the Indian carps, groups of species of various, mostly herbivorous, feeding habits that live well together in a pond. (Fig. 3) While they are more difficult to spawn than the common carp, they are suitable for low cost culture, prominently demanding skill and labour, to have farmers attain yields of 5 or even 10 t/ha.

The large tropical fresh water fish family *Cichlidae* contains several related species that now promise to vie with all other cultured fishes for the title of "aquatic chicken".[8] They go under the popular name tilapia, a term comprising several species.

The biology of aquatic animals, and the nature of their medium are such that we have chosen mostly carnivores among the fishes, for attempts at domestication in the ocean especially. If their production per unit volume of water is to be increased they have to be given food from the outside. Those that live on plankton, molluscs, tilapia and certain carp will require attention to levels of edible biomass that can be grown or that is naturally available in their surroundings. Since food relations in the sea are highly complex, different species have different food requirements, even to some needing compounds that are not necessary for others. The mahi mahi or dolphin fish (*Coryphena hippurus*), which is being considered for culture because of its fast growth and

FIGURE 3 Habitat and feeding niches of the principal species in classical Chinese carp culture.

Grass carp *(Ctenopharyngodon idella)* feed on vegetable tops. Bighead carp *(Aristichtys nobilis)* feed on zooplankton in midwater. Silver carp *(Hypophthalmichthys molitrix)* feed on phytoplankton in midwater. Mud carp *(Cirrhinus molitorella)* feed on benthic animals and detritus, including grass carp feces. Common carp *(Cyprinus carpio)* feed on benthic animals and detritus, including grass carp feces. Black carp *(Mylopharyngodon piceus)* feed on mollusks.

SOURCE: Adapted from: J. E. Bardach, T. H. Ryther, and W. O. McLarney, "Aquaculture: the Farming and Husbandry of Fresh Water and Marine Organisms," Wiley Interscience (New York and Chichester: John Wiley & Sons, 1972).

market qualities, needs some compounds derived from squid (one of its natural foods) which are not required in salmon feed, for instance. Shrimp seem to be particular with regard to certain vitamins and growth factors while other cultivars such as certain tilapias have more catholic food requirements.[9]

The importance of larval feeds has already been mentioned as has the need for understanding specific nutritional requirements. Pelleted artificial feeds are being developed for many culture situations even to include attention to the large role that smell and taste play in the feeding of aquatic animals. In fact, since the cost of feeding fish-eating fishes (salmon, trout, groupers, yellowtail and others) and of shrimp can make up one half or more of the cost of rearing them, feed research is very important in the further development of aquaculture.

Such research is now directed to make the feed not only better but also cheaper; components of fish meal can be replaced by other protein containing ingredients such as soybean meal — up to a point. The sulfur containing amino acids still have to be supplied from other sources. Manipulation of plant — or bacteria — derived proteins to have these acids incorporated in them through "Plastein synthesis" shows promise, especially as food technology becomes applied to more direct utilization of the vast tonnage of clupeiod fishes that now supply the fish meal. Here, again, feeds have to be tailored to specific requirements and salmon feeds for instance, have achieved a greater degree of fishmeal replacement than shrimp feeds. Such advances in feed quality and

costs will, of course, furnish important background to the possible introduction of new species into the roster of cultured marine animals.

Marine rather than freshwater animal farming will receive emphasis because the next few decades will see such high demand on fresh water itself, for urbanization and irrigation, that little expansion of fresh water aquaculture can be expected, with the exception perhaps of tropical river flood plains and reservoirs behind new dams in rivers.[10] If high tonnages per unit volume are desired largely by ecosystem management, in fresh water, at least, fertility control has been and will continue to be the key as it is in a very satisfactory mode of rearing complexes of naturally occurring ratios of fish species together in ponds in China and India (Fig. 3). Such ponds contain much biomass, and their management requires fine tuning of the fertility of the water, pond bottom, and oxygen content. Since this method of management, called polyculture (the mixing of fish with different feeding habits and/or from a number of regions), requires a high degree of organic nutrient input, such ponds may, in fact, be managed as parts of larger farm units. They are then the pivots of aquatic and terrestrial animal husbandry complexes including geese, ducks, pigs and even cattle with a truly staggering output of edible flesh, milk and eggs per hectare. These rely, however, on a few long selected species and a greater application of labour than many other aquaculture enterprises.

Marine aquaculture is now also based on relatively few principal species (Table 4) and, with the exception of oysters, the tending of which goes back to Roman times, as mentioned, mariculture has less of a tradition than freshwater pond culture. Adding to the number of presently cultured species would depend on how complicated the life cycles of the new cultivars might be; (complete control over the shrimp, with a prevalence of hatcheries in many places, after all, goes back only a decade or two). Developing new species for aquaculture also depends on market forces but, all in all, it is not likely that the number of marine cultivars will increase commensurate to numbers of higher priced species in the fisheries. Attention to some engineering parameters in culture methods of already tended species (i.e. intensification), to disease control and to water quality will pay off higher dividends than research into new species.

An example of the role of engineering, of water supply and quality is OTEC related aquaculture, location-limited as it may be. Ocean Thermal Energy Conversion, OTEC for short, is an energy source for the tropics now under development. Its perfection will, no doubt, be speeded by the search for non-polluting power generation that is not based on fossil hydrocarbons. It relies on the relatively small temperature difference between tropical surface waters and the cold layers below the thermocline. Both water sources are clean and the cold one is essentially without contaminants; it also contains a moderate supply of nutrients. Having both piped warm and cold sea water at one's disposal, one can adjust the temperature of the water for aquaculture and therefore grow both temperate and warmwater species with brown algae, abalone, salmon and yellowtail as well as groupers being potential cultivars. The present experiments are conducted in tanks and ponds on land but floating

TABLE 4. Aquaculture production in the temperate region of Western Europe and America

Species	Production System	Areas	Indicative Value 1985 (S.t)	Full or partial controls
RAINBOW TROUT Salmo gairdneri	Intensive tank raceway, pond cage culture	Cool temperate N USA, N & W Europe	1000 2000 for large fish	Fry, fingerling, normal, freshwater grow-out, fattening seawater grow-out
CHANNEL CATFISH Ictalurus punctatus	Semi-intensive pond culture	Warm temperate or sub-tropical South USA, Spain, Italy	1000	Fry, fingerling, Large finger
ATLANTIC SALMON Salmo salar	Freshwater smolt in tank cages, then seawater tank cage	Cool temperate N Europe, coastal USA, Canada	4000	Egg production, smolt (fingerling) grow-out
PACIFIC SALMON Oncorhynchus spp.	Many reared in hatcheries for release to wild; brood caught; some cage culture	Coastal NW USA & Canada Gt. Lakes E Seaboard	200 2000	Fry, fingerling, pan-size grow-out
EEL Anguilla anguilla	Intensive tank, pond, lagoon; some in recycled fresh and salt water	Warm temperate or heated water	2000- 4000	Elver supply, part-grown, grow-out
TURBOT Scopthalmus	Intensive tank, pond, experimental cage; saltwater	Originally heated water, now warm temperate	2000- 3000	Larval production, grow-out
DOVER SOLE Solea solea	as for Turbot	as for Turbot	2000- 3000	As for Turbot
HALIBUT Hippoglossus hippoglossus	as for Turbot	Experimental	2500- 4000	Experimental
COD Gadus morhua	Cage reared, saltwater	Experimental	1000- 1500	Experimental
SEABASS Dicentrarchus labrax	Cage, tank, pond, lagoon; brackish, salt water	Warm temperate France, Italy, Greece, N Africa, Israel	5000	Hatchery, grow-out
GILTHEAD (SEA) BREAM Sparus auratus	Pond, lagoon, some cage tank, brackish, salt water	As above	5000	As above
MULLET: SEVERAL SPECIES Mugil liza spp.	Pond, lagoon; brackish, salt water	As above	1000-	Grow-out some experimental
TILAPIA: SEVERAL SPECIES Serotherodon spp.	Pond, cage, some intensive tank culture, Fresh and salt water	Warm temp. or subtrop. Also heated effluents S Europe, USA	500- 1500	Hatcheries Fingerlings (over-winter), grow-out
CARP Cyprinus carpio	Pond culture	Middle Europe, Israel	1000- 1500	Hatcheries grow-out
MISC. FRESH WATER Pike, Perch, Walleye, Sturgeon	Restocking	Europe, USA	N/A	Fry production
SHRIMP Penaeus spp.	Pond, expl. tank culture Brackish, salt water	Sub-tropics, Tropics Mediterranean, S America	3000- 8000	Larval production, grow-out
PRAWN Macrobrachium spp.	Pond Fresh, brackish water	As above, also Hawaii	2000	As above
CRAYFISH Astacus sp. Pantastacus Procambarus	Ponds Fresh water	Mild to warm temperate, Hard waters	2000- 4500	Larval supply part grown, grow-out
OYSTERS, MUSSELS	Raft, rope Bed, bag culture Brackish, salt water	Wild range environments N. America, Europe	Mussel 100-500 Oyster 1000-1500	Hatcheries, part growing, grow-out

basins associated with future larger plants are likely to be developed since moving water over any distance adds to the operating cost. The small temperature difference on which OTEC depends demands the use of enormous quantities of water for the generation of power. This is one of the problems of OTEC, because it makes the initial capital costs of the installation so high that they would only be recovered over time by the virtual absence of fuel costs.[11] Operating water has to be voided and, being somewhat fertile, it presents a further challenge for aquaculture use and for synergy with power generation.

The latter culture could be loosely patterned after open ocean culture practices now being developed in Japan: Fisheries cooperatives and research organizations have reared sea bream (*Pagrus major*) with the help of fish shelters deployed down to ca. 60 m depth. The fish are hatched and trained to associate food with sound and released into coastal waters as juveniles. These waters are studded with fish shelters for many kilometers in extent. The rearing costs are not low but they are offset by the shelters being fashioned from industrial waste materials.[12]

The method could be adapted to other fishes and need not be associated with OTEC which, incidentally could also furnish domestic fresh water as an important by-product. The overall combination illustrates both the possibility of controlled ranching in the sea and the benefit from combining features of the power industry with aquaculture (Fig. 4). Comparable developments are also underway with warmed effluents from power plants in Europe, as sources of heat for speeding the growth rate in high-density culture of tilapia. Various synergies of aquaculture with other industries are possible and they will, no doubt, be explored. They will be site-limited and water quality may well turn out to be the criterion here.

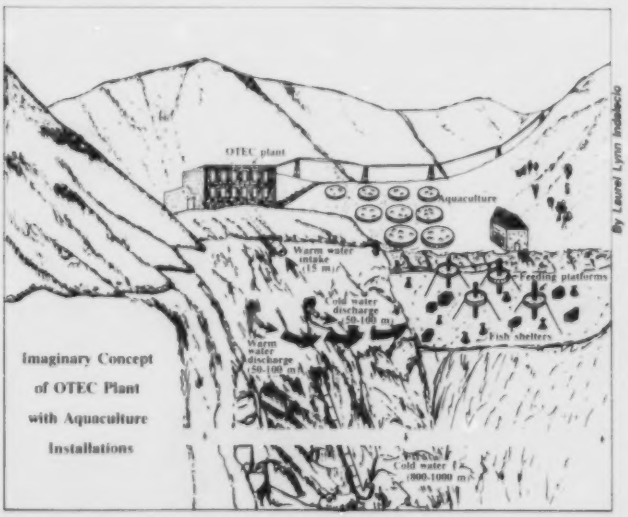

Figure 4. Imaginary Concept of OTEC Plant with Aquaculture Installations

WATER QUALITY

Where rich plankton pastures are required, as in polyculture attained by fertilization, or in mollusk rearing, the prime factor to watch may be oxygen content of the water and its inevitable decline at night. When one feeds the animals directly, as with catfish or trout or in some shrimp-rearing methods, there may also develop a dangerously low level of oxygen caused by decomposing excess food and by the excreta of the many animals kept in confinement together. Both adverse conditions can lead to stress, poor health, and infections with many diseases and parasites.

In fact, disease outbreaks have been the most important constraints to aquaculture in many regions.[13] Entire aquaculture operations involving millions of dollars have disappeared because of the inability to control disease. For example, several kinds of bacterial infections, although eventually brought under control, began to assail caged yellowtail in the inland Sea of Japan. It should be added that the kinds of diseases multiplied as culture sites increased during the years. While bacterial infections eventually yield to antibiotics, viral infections are virtually incurable. In Hawaii, where shrimp culture is under development, a virus appeared in an introduced species. The only solution was to eradicate all animals of that species in the islands and start over with disease-free stock. Breeding programs to attain disease-free stocks of the important aquaculture species will be a prime need in the future of aquaculture.

With increasing competition for use of riparian land and water, occurrences of pollution have multiplied. It is a case in point that unprecedented outbreaks of red tide along the coast of Northern China prompted officials to call for strict measures to stop the dumping of wastes into the sea. The *China Daily* (of 11 April 1990) reported that the phenomenon has caused extensive losses to seafood cultivation along the country's southern coast for decades, but it has recently invaded the north. This is bad news for the world's largest shrimp producer. On the other side of the world, the Baltic Sea coast also suffered from algal blooms and salmon culture in the region was severely affected. Also, self-pollution from aquaculture or unwanted enrichment by fish and shellfish farm effluents have been overlooked in the past. They are now receiving attention (Table 5), and the threat of eutrophication from aquaculture effluents is now included in the environmental impact statements for new sites, at least in Western nations and in Japan.

PROGNOSIS AND CONCLUSION

Influences that would enhance the development of aquaculture and those that would hinder it have been presented. One may now evaluate their interplay and venture a glimpse at the future of aquatic animal husbandry.

Demographic forces and their consequences will lead to a lower availability of wild stocks in many regions. Incentives to augment such shortfalls with cultured species will foster aquaculture development, especially among higher priced species. For instance, over half of the volume of shrimp in the

Table 5. Effects of Fish-Farm Effluents on Receiving waters in Finland (after Rosenthal 1985)[13]

Type of effect	Number of cases
Eutrophication	22
Increase in phosphorus content	15
Increase in bacterial counts	11
Lowered oxygen content	9
Algal blooms	8
Sewage fungus and settled solids	5
Increase in chlorophyll a	4
Increased macrophytes	3
Increased water turbidity	2
Smell	2
Bad fish taste	2
Water not potable	2
Restricted use of potable water	1
Fish kills	1
Changes in benthic fauna	1
Polluted fish traps	1
Deteriorated fishery	1

Note: Results are based on a 1981 survey of 200 fish farms.

Source: Modified from H. Rosenthal, "Constraints and Perspectives in Aquaculutre Development", *GeoJournal* 10, no. 3 (1985): 305-24.

world food trade is likely to come from culture, by the year 2000.[14] Salmonid fishes, likewise, will soon be supplied to markets mostly from hatchery reared, ranched or cage-based operations and eels, though only in their grow-out phases, will come largely from aquaculture establishments. The list could be extended, though it would mostly comprise luxury fare.

Some new attractive species such as flat fishes, perhaps even lobsters will, no doubt, be grown if their life cycles can become closed, but with them, as well as with the intensification of the culture of already established species, success in rearing them to market sizes will require increasing attention to environmental economic, social and legal influences on the industry.

For instance, there is the difficulty, not always appreciated especially among smaller intrepreneurs, of having capital to await the profit phase of newly established aquafarms (Table 6). There is the matter of competition for both site and water use; it can be safely predicted that fresh water will be a scarce commodity in many parts of the world, in the next century,[15] even without considering the regional effects of possible global warming.

Table 6. Cash flow patterns in aquaculture.

Year	1	2	3	4	5
Salmon	Holding stock feed	Small harvest	Main harvest	First positive cash flow	Main positive flow
Trout	Holding stock, feed	First harvest	First positive flow	Main positive flow	
Catfish	Holding stock feed, first harvest	First positive flow	Main positive flow		
Eel	Holding stock, feed	Small harvest	Main harvest	First positive cash flow	Main positive flow
Salmon Ranching	Holding stock, feed	First release	—	First returns, possible positive flow	Main flow year 8+
Salmon Hatchery	Holding stock	Feeding	First cash flow	Main cash flow	
Catfish	Holding stock	First sales, positive cash flow	Main cash flow		

Source: after Muir 1985.[18]

Entitlements to sites where aquaculture can be done has been a problem especially in developing nations, and together with these go conflicts over shorezone use which may also be influenced by culture. One has only to look at considerations of visual impacts in environmental impact statements in the USA to appreciate difficulties for unfettered developments of aquaculture, even in sites that are well suited for it.

Considering the global picture in nutrition, it bears repeating, perhaps, that animal protein of marine origin is of greater importance in certain parts of the world than in others (Table 2), and that the yield of wild-stock fisheries has clear but periodically fluctuating upper limits, as certain fish populations reach peaks while others decline, e.g. the Alaska pollock and the Japanese sardine are now at peak.[16] Neither species, is suited for aquaculture by virtue of their biology and behaviour; should they decline again they and other species similarly unsuited for aquaculture will not likely be subjects for aquaculture research and development. New species will appear, though, such as certain flatfishes; however, they comprise but a small portion of national, let alone

global, consumption. Experiments now underway with a few other species, such as the giant clam, *Tridacna* in the tropical Pacific, may eventually assume some regional importance. The big clam needs no feeding because it lives in symbiosis with algae that make its food; its dried flesh could help in diversifying diets on islands with rapid population growth.[17]

By and large, though, the bulk of cultured species will be those that are already domesticated and increases will happen largely through intensification of present and semi-intensive methods, especially in near-shore marine and brackishwater environments. If positive forces in their development prevail over negative ones[18] (Table 7) one may well look to a doubling of fish, mollusc and crustacean yields from culture operations in the first quarter of the 21st century. Assuming that wild-stock fisheries will also grow during that period, although not as fast as in the third quarter of this century, aquaculture could then make up between 20 and 25 per cent of all directly consumed fish and the like. Their wild stocks will, however, continue to be the principal suppliers of fishes and other aquatic food.

Table 7. Factors influencing aquaculture development.

Negative Factors	Positive Factors
Cost of water supplies, waste treatment	More efficient water use, planning
Seabed rights, increased costs	Systems for more exposed sites
Longer-term environmental charges	Better Understanding of environmental factors
Consumer issues — husbandry, channels	Development of marketing opportunity
Feed input cost rises	Improved feed technology, formulation
Concentration of production, large producers	Simple techniques for small-scale use
Increasing disease transfer	Better disease control
Legislative controls	Better industry representation
Marketing problems	Marketing organizations
Stock supply limitations	Improved hatchery techniques
Shortage of trained staff	Improved training, wider knowledge
Competitive Pressure	Better production techniques

Source: After Muir 1985.[18]

ENDNOTES

1. Food and Agriculture Organization. *Fisheries Statistics for years 1977-87.* FAO, Rome.
2. Gjedrem, T., Improvement of Productivity through Breeding Schemes. *GeoJournal* 10 (3), 1985, pp. 233-241.
3. Schäperclaus, W., Neue Düngungsversuche mit Karpfen. *Deutsche Fischerei Zeitung* 13 (1),1965, pp. 6-14.
4. *Ibid.*
5. Encyclopedia Britannica, Vol. 1 (Animals). 1957 edition.
6. Bardach, J.E.; Ryther, J.H.; McLarney, W.O., *Aquaculture. The farming and husbandry of freshwater and marine organisms.* New York: Wiley Interscience, 1972.
7. Hora, S.L. and Pillay, T.V.R., Handbook on Fish Culture in the Indo-Pacific Region. *FAO Fisheries Biology Technical Paper #14*, 1962.
8. ICLARM, Tilapia, the aquatic chicken. *ICLARM Newsletter #7*, 1984. International Center for Living Aquatic Research Management, Makati, Metro Manila, Philippines.
9. Bienfang P., Vice-President, The Oceanic Institute, Makapuu Point, Oahu, Hawaii. Personal Communication. April 1990.
10. Welcome, R.L., *Fishery Ecology of Floodplain Rivers.* London and New York: Longman, 1979. 312 pp.
11. OTEC Library, *Ocean Thermal Power Plants. Technology Assessment.* Washington, D.C.: U.S. Congress, 1980. 32 pp.
12. Nose, T., Recent Advances in Aquaculture in Japan. *GeoJournal* 10 (3), 1985. pp. 261-276.
13. Rosenthal, H., Constraints and Perspectives in Aquaculture Development. *GeoJournal* 10 (3), 1985. pp. 305-324.
14. Aquatic Farms Ltd., "Asia-Wide Shrimp Agro-Industry Sector Study" Submitted to The World Bank. April 1989. The World Bank, Washington, D.C., 1990.
15. *Ibid.*
16. Food and Agriculture Organization, *op. cit.*
17. Munro, I.L., *Fisheries for Giant Clams (Tridacidae: Bivalvia) and Prospects for Stock Enhancement in Marine Invertebrate fisheries: Their assessment and management.* John Wiley & Sons., 1988. pp. 541-558.
18. Muir, J.F., The Role of Aquaculture in the Industrial Regions of the Temperate Zone. *Geojournal* 10 (3), 1985. pp. 277-298.

MICHAEL WALDICHUK*

Industrial and Domestic Pollution in the North Pacific†

INTRODUCTION

The Pacific is the world's largest ocean with an area of just over 165 million km^1 and a volume of 707.6 million km^2, when the adjacent seas are excluded, or 53.5 per cent of the volume of the global oceans. It has a mean depth of 4,282 m. It is roughly circular in shape, and the equator splits its area in two nearly equally. Thus the North Pacific can be regarded as containing roughly one-quarter of the volume of the water of the global oceans. The larger islands border Asia and Australia. The open Pacific is dotted with numerous island archipelagoes, which are located for the most part in the tropical and sub-tropical regions, primarily in the southern hemisphere. The oceanic islands, some of which are of volcanic origin while others are atolls formed by the coral growths on sea mounts, constitute a comparatively small proportion of the area of the whole Pacific. The human populations on these islands are relatively small.

The North Pacific is rimmed with land territory that ranges from the most densely populated (Southeast Asia, China and Japan) to the most sparsely populated (British Columbia, Alaska and eastern Siberia) in the world. Most of the marine pollution is confined to coastal waters, and can generally be considered proportional to the density of the coastal population and industry. Coastal waters act as a massive filtration system greatly inhibiting the movement of contaminants from land-based sources to the open ocean. Hence, waters of the open North Pacific are still comparatively clean. However, certain contaminants reach the deep sea by other routes, such as ships and the atmosphere, and in some cases as with solid refuse, for example, these have caused problems.

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† Paper presented at the symposium, "Marine Resources of the North Pacific", University of Victoria, 6 June 1990.

In this paper, I shall review some of the sources of contaminants in the North Pacific and the state of marine pollution by petroleum hydrocarbons, halogenated hydrocarbons, metals, radionuclides and solid wastes, particularly the persistent plastics. The problems arising from sewage disposal in various areas of the Pacific Rim will also be examined. It is hoped to identify some of the major problems of marine pollution that exist at present in the North Pacific, and to note the trends in concentrations of some of the traditional contaminants. An attempt will be made also to examine the role of the North Pacific, as part of the world oceans, in ameliorating the global impact of the "greenhouse effect" of radiatively active gases, and the potential consequences of contamination that could reduce this role.

SOURCE OF CONTAMINANTS IN THE NORTH PACIFIC

By far the largest input of contaminants to the North Pacific stems from land-based sources. This may come by way of rivers, direct outfalls into the sea from industries and municipalities, atmospheric transport, urban and agricultural runoff, ocean dumping, and leaks and spillages of toxic substances from coastal industrial installations. Except for atmospheric transport and ocean dumping, the contaminants from land-based sources are waterborne and must pass through estuaries and coastal waters before they reach the open sea. There are various biogeochemical processes in estuaries and coastal waters that tend to remove the contaminants from the water and deposit them in estuarine and coastal sediments. Only a small proportion of contaminants in dissolved and particulate form eventually reaches the open ocean.

Airborne contaminants, on the other hand, may reach the open ocean with less interference than waterborne contaminants, depending on the prevailing winds. They enter the sea surface as dry fallout or in the form of wet precipitation after being washed out of the atmosphere by rain. In the North Pacific, airborne contaminants are transported long distances by westerly winds from continental Asia and Japan, shown by the flux of mineral aerosol from the atmosphere to the oceans in Figure 1 (1). The amount of particulate mineral matter collected in Oahu of the Hawaiian Islands during 1981-82 was strongly correlated with the incidence of dust storms in China (2).

Substances that enter the North Pacific through ocean dumping may consist of various materials derived on land, such as sewage sludge and excavation spoils. A large proportion of the substances, however, are dredged materials taken from inshore waters to clear navigational channels and deepen berths for vessels at wharves. Usually there is control under national legislation, as in regulations under Part VI of the Canadian Environmental Protection Act, to prevent heavily contaminated sediments or other materials from being dumped at sea. Dumpsites are often located in coastal waters in reasonably close proximity to areas where sediments are dredged. On the south coast of British Columbia, these are the Point Grey dumpsite near Vancouver, the Sand Heads dumpsite in the Fraser River Estuary and the Victoria dumpsite in Juan de Fuca Strait near the Quarantine Buoy (Fig. 2) (3). For substances that might pose a

threat to nearshore living marine resources, there is also a deep North Pacific Ocean dumpsite with a depth of 1100 m, located 100 km due west of the southern entrance to Juan de Fuca Strait.

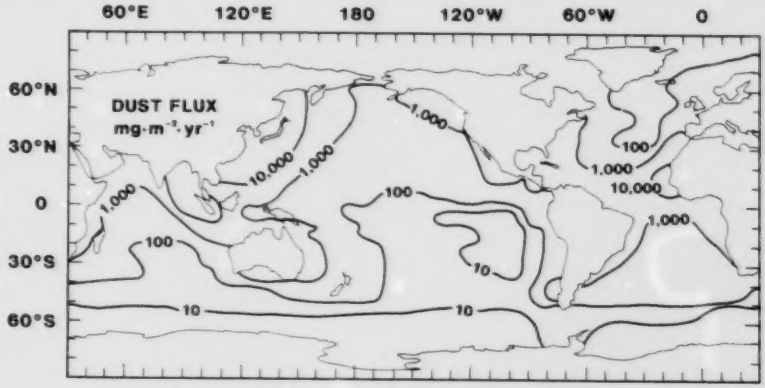

Figure 1. Global fluxes of mineral aerosol from the atmosphere to the oceans annually. [From GESAMP, 1989 (1)]

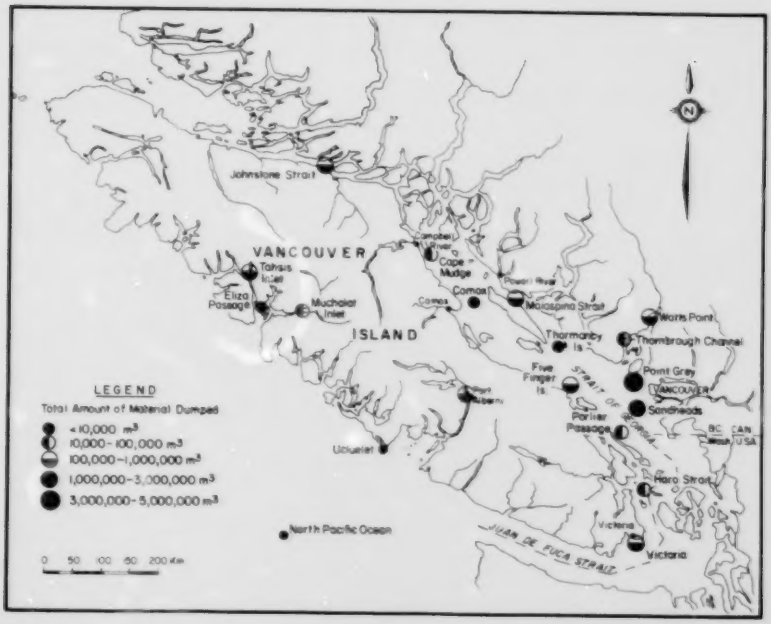

Figure 2. Active ocean dumpsites in southern British Columbia. [From Kay 1989 (3)]

Ships are a source of contamination, both in the form of ship-generated garbage and spilled cargo during collisions and groundings. The most dramatic spills of cargo occur during collisions and groundings of oil tankers, as exemplified by the 24 March 1989 spill of 41 million litres of crude oil from the *Exxon Valdez* in Prince William Sound, Alaska. Smaller spills and chronic leaks of oil and other noxious substances carried by ships may be less conspicuous, but in aggregate, may be quite substantial over a period of a year. Likewise, discharge of ship-generated garbage, particularly the persistent synthetic materials, may be transported long distances by surface currents at sea to become eventually deposited either on the bottom or on some distant shore. Although accidental discharge from ships during collisions and groundings will continue, deliberate discharges are being increasingly controlled by the Convention on the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (referred to as MARPOL 73/78), and by national legislation, such as Part XX of the Canada Shipping Act. A large source of debris at sea, particularly discarded nets, is fishing vessels. Assorted refuse comes also from recreational vessels; such persistent materials as plastic bags and six-pack yokes can pose a hazard to birds, marine mammals and sea turtles. Efforts are being made through education and information media to reduce the amount of refuse stemming from these smaller vessels.

CRITICAL INDUSTRIAL CONTAMINANTS

The industrial contaminants that are regarded here as being critical are those that are toxic, persistent and tend to be bioaccumulated by marine organisms. Some of the contaminants may possess all three of the properties; others may be characterized predominantly by one of the properties without exhibiting any of the others. Persistent plastics, for example, are usually neither toxic nor bioaccumulative within the normal meaning of the terms. The classes of substances that will be discussed in the following sections have been grouped into five major categories: 1) petroleum hydrocarbons; 2) halogenated hydrocarbons; 3) metals; 4) radionuclides; and 5) solid wastes, particularly the persistent plastics.

1. Petroleum Hydrocarbons

Pollution by petroleum hydrocarbons in the North Pacific is confined to coastal waters, in the vicinity of large urban communities and along the major maritime transportation routes. There is some transport of spilled oil from these coastal zones and routes by surface currents, of course, to other areas. The maritime transport of oil in the North Pacific ranks considerably lower in volume than that transported in the Atlantic (Fig. 3) (4), where there is a large volume moving from the oil fields in the Middle East to European nations importing the oil. Most of the maritime transport of oil in the North Pacific is from south to north along the eastern seaboard of Asia, where Middle East oil is being moved to Japan. A modest amount of oil is transported from north to south along the western seaboard of North America from the Prudhoe Bay oil

fields of northern Alaska, via Valdez, Alaska, to the more southerly ports in Washington, Oregon and California, or to the eastern U.S.A. through the Panama Canal. A comparatively small amount of oil traverses the North Pacific from the Middle East and Southeast Asia to ports in California. Hence, oil pollution due to deliberate discharges from tankers and from tanker accidents in the North Pacific is usually confined to the narrow coastal stretches along the Asiatic and North American coastlines.

Figure 3. Major oil movement by sea in 1979. The width of the arrow represents the relative volume of oil. [From Clark, 1986 (4)].

Marine transport of oil contributes petroleum hydrocarbons to the oceans through tanker operations, marine terminals, tanker accidents, bilge discharges and other accidental and deliberate releases. The most dramatic inputs, of course, are from tanker accidents. The public can readily see these spills and their effects, particularly on sea birds. They receive much media attention. On a global scale, however, tanker accidents were estimated to contribute only 18 per cent of the total petroleum hydrocarbons introduced into the oceans in the 1975 US National Academy of Sciences assessment (5) and 12.5per cent in the 1985 assessment (6). A larger proportion of oil transported by sea enters the oceans by way of tank washings, discharges of oily ballast water, leaks from tankers and tanks at oil terminals and small accidental spills in tranferring oil from tankers to shore facilities and *vice versa*. It is these types of chronic inputs of oil that lead to higher-than-background levels of oil in the sea. The highest concentrations of oil in the marine environment correspond to the tanker routes of the world oceans (7). The total global marine input of oil stemming from transportation was estimated to be 35 per cent of the total global input in the 1975 report and 46 per cent in the 1985 document (5,6).

The percentage of the total input of oil into the North Pacific that can be attributed to transportation is probably not too different from the global percentage.

On a global basis, panels of experts working under the US National Academy of Sciences estimated for the period 1969-1971 that 6.113 Mt (million metric tons), with a probable range of 4.7-7.8 Mt, of petroleum hydrocarbons entered the world oceans each year (5), and for a decade later, 3.2 Mt, with a probable range of 1.7-8.8 Mt (6). A significant reduction of the estimated discharge of petroleum hydrocarbons into the marine environment from 1970 to 1980 occurred in transportation, which dropped from 2.133 Mt to 1.47 Mt. Another significant decrease in estimated input of petroleum hydrocarbons during the 10-year period was in the river and urban runoff, which dropped from 1.9 Mt in 1970 to 0.16 Mt in 1980. While the decrease in input of oil from transportation is believed to have actually occurred because the estimate of this source can be made quite accurately, it is uncertain whether the oil input from river and urban runoff was a real decrease or an improved estimate in 1980 over that in 1970, owing to improved measurement techniques.

Until 1988, the North Pacific has been generally free of the massive oil spills experienced elsewhere. There have been a few modest-sized oil spills on both sides of the North Pacific, however, which have not received much public attention. For the eastern North Pacific, these include: *Tampico Maru*, off the coast of Baja California, Mexico, March 1957, 9.5 ML (million litres) of diesel oil; *R.C. Stoner*, at Wake Island, September 1967, 20 ML of jet fuel, turbine oil and Bunker oil; *Arizona Standard* and *Oregon Standard*, in San Francisco Bay, January 1971, 3.2 ML of Bunker C; March Point Dock Facility, Anacortes, Washington, April 1971, 0.8 ML of No.2 fuel oil; and *General M.C. Meigs*, in Wreck Cove, Washington, January 1972, 0.48 ML of Navy special oil. On the coast of British Columbia, significant early oil spills included: *Vanlene*, in Barkley Sound, 14 March 1972, 0.33 ML of Bunker B oil; *Irish Stardust*, in Blackfish Sound, near Alert Bay, 24 January 1973, 0.40 ML of Bunker C; and *Erawan*, at the entrance of Burrard Inlet, near Point Grey, 25 September 1973, 0.23 ML of Bunker C.

Similar types of spills no doubt occurred, but likely more frequently because of the larger volume transported, in the western North Pacific in coastal waters of Japan, China and Korea. The number of oil spills of over 795,000 L (5,000 barrels) occurring from tankers in the North Pacific, including Southeast Asia, during the period 1974 to 1979, inclusive, was twenty with fourteen in the western North Pacific and six in the eastern North Pacific. During the period 1980-1985, inclusive, there was a total of five such spills in the North Pacific all of which occurred on the western side. The total number of such spills in the remainder of the world oceans during the corresponding periods was 64 and 36, respectively (8).

The record of a comparative lack of major oil spills in the northeast Pacific was shattered in late 1988 and early 1989. On 22 December 1988, the barge *Nestucca* was struck by its towing tug in heavy seas off the southwest coast of Washington State. It leaked 875,000 L of Bunker C oil into the sea. The

leaking barge was towed 40 km out to sea to avoid polluting Grays Harbour and the ecologically sensitive oyster beds and water fowl sanctuary of Willapa Bay, on the southwestern coast of Washington. The prevailing currents and winds moved the oil northward and onshore, where it did serious damage to the outer coast of Olympic National Park in Washington State and Pacific Rim National Park on the west coast of Vancouver Island, British Columbia. Not only seabirds were affected in coastal areas of both national parks, but also the endangered sea otters on the central west coast of Vancouver Island were threatened. The crab, gooseneck barnacle and molluscan shellfish fisheries in the area affected by the oil, near Pacific Rim National Park, had to be closed. The damage to living resources and the costs of cleanup were vastly out of proportion to the size of this comparatively small oil spill by global standards.

A massive oil spill occurred on the route from Valdez, Alaska, to Long Beach, California, on 24 March 1989, when the tanker *Exxon Valdez* struck Bligh Reef in Prince William Sound. Subsequently, 41 ML of crude oil were spilled into the Sound, which made this the largest oil spill in US history and tied for the third largest in the world. Not only were over 30,000 seabirds known to be killed by the spilled oil, the mortality of sea otters, of which there was a population of about 10,000 in Prince William Sound, probably far exceeded the more than one thousand that had been counted (9). The oil contaminated an estimated 500 km of shoreline, generally to the west of the oil spill location, which had to be systematically cleaned with high-pressure water and steam. By September 1989, it was estimated that 8,000 people were involved in the cleanup and the cost to Exxon for the cleanup operations had reached $1 billion.

Oil has been transported on the run from Valdez, Alaska, to southern ports since 1977, with few mishaps of significant oil spills in nearshore waters. The *Exxon Valdez* disaster can only be attributed to gross human error arising from complacency and general laxity in navigational procedures. Two sizable spills (ca. 10^6 litres) were reported for the run during the winter of 1987, but these were in offshore waters and became totally dispersed before reaching any shores.

While the *Exxon Valdez* oil spill caused ecological damage of enormous proportions in Prince William Sound and contiguous waters, which will last for many years, the widespread chronic oil pollution along the coastline of Pacific Rim countries may be more important in the long term. Oil pollution is regarded as a major problem along the coast of China and in semi-enclosed bodies of water, such as the Seto Inland Sea, in Japan. It is also a problem in similar bodies of water along the Pacific coast of North America, such as San Francisco Bay, California, and Burrard Inlet, British Columbia, where tankers transport crude oil to refineries and refined products from the refineries to consumers at distant places.

It is generally believed that the decrease of inputs from transportation is real and not an artifact of improved technology in estimation of inputs. For one thing, there has been a reduction by 430 Mt, or 25per cent, on a global scale from 1,724 Mt to 1,293 Mt, in the total amount of crude oil and finished

products transported by sea annually from 1977 to 1986 (8). Only 44 per cent of the world oil consumption was moved by sea in 1986 compared to 58 per cent in 1977. Contamination of the seas by oil tankers is decreasing also as a result of greater care in transferring oil from tankers to shore facilities, and vice versa, and in cleaning tanks. The Load-on-Top system has been generally adopted by tankers. The techniques for separation of oil from oily bilge water and from ballast water have become more efficient. Terminal facilities have also been equipped in many ports to accept oily bilge and ballast waters for recovery of the oil, as part of national and international regulations to control oil pollution from maritime transportation.

Control of oil pollution from ships is now regulated internationally with the coming into force in 1983 of the International Convention for the Prevention of Pollution from Ships, 1973 (10), as modified by the Protocol of 1978 relating thereto (MARPOL 73/78). Annex 1 of the Convention deals with oil and is mandatory for all Contracting Parties ratifying MARPOL 73/78. While oil spills, such as those of the *Nestucca* and the *Exxon Valdez*, will continue to occur because of human error, techniques of containment and recovery of the spilled oil will undoubtedly improve. It can be expected that inputs of petroleum hydrocarbons into the North Pacific from marine transportation will decline as national authorities further tighten up regulations on operation of tankers and controls on oil losses from ships through national legislation, conforming in the minimum to requirements of MARPOL 73/78. Tankers are now required under MARPOL 73/78 to have segregated ballast tanks — to be used only for ballast water — and crude oil washing systems — for recovery of oil — on board to minimize the release of oily water into the sea.

Local coastal pollution problems from crude oil spills [e.g., Smith 1968 (11)] and refined product spills [e.g., Sanders *et al.* 1980 (12)] along the Pacific Rim will inevitably continue, but probably at a reduced level. The recent *Exxon Valdez* oil spill will undoubtedly lead to more stringent regulations in the transport of oil by sea. High-seas oil pollution in the North Pacific will likely steadily decline, as new preventative measures are introduced and existing ones are more rigorously enforced. Contamination of offshore waters by oil will continue to coincide with the major tanker routes. Oil films and tar balls will usually be found along the major tanker routes, as in the past, but these will be more often from accidental spills and leaks than from deliberate discharges of oily bilge water, oily ballast-tank water and washwaters from oil-carrying tanks. Some of the floating residues from oil spills and leaks will continue to concentrate in convergence zones of the North Pacific, as noted by Day and Shaw (1987) (13).

A special problem associated with crude oil and its products are the polycyclic aromatic hydrocarbons (PAHs), which are not only toxic but some, e.g., benzo-a-pyrene, may also exhibit carcinogenic properties. PAHs are a class of constituents in crude oil. They are also natural combustion products from forest fires and are present in atmospheric emissions from incinerators and aluminum smelters. They occur in great abundance as waste products from coke ovens used to produce coke for steel manufacturing, as found in Sydney

Harbour, N.S. (14). They are also released into water and sediments from creosoted pilings. PAHs are present in virtually every harbour that has marine transportation. They pose a particular problem in coastal waters of British Columbia at present whenever there is a proposal to dredge a harbour, an area adjacent to a pulpmill or a sawmill, or in the vicinity of any other industry.

PAHs, among other contaminants, have been found in sediments of Vancouver Harbour (15). English sole, *Parophrys vetulus*, captured over these PAH-contaminated sediments, were found to exhibit a comparatively high incidence of skin tumours and pre-cancerous liver lesions. A national group of experts developed guidelines on chemical analyses for PAH concentrations in sediments and on levels acceptable for ocean dumping (16). These guidelines have been adopted, on an interim basis, by the Regional Ocean Dumping Advisory Committee (RODAC), Pacific and Yukon Region, in dealing with ocean dumping applications. The screening level for total PAHs (TPAH) is 2.5 ppm, dry wt. Sediments having PAH less than 2.5 ppm are allowed for ocean disposal, provided they meet the requirements for other constituents. Sediments that contain more than 50 ppm, dry wt, of high molecular weight PAHs (HPAH), and/or more than 6 ppm, dry wt, low molecular weight PAHs (LPAH), are rejected for ocean dumping. Those sediments that exhibit TPAH of more than 2.5 ppm, but less than 50 ppm HPAH and/or less than 6 ppm LPAH, must be subjected to bioassays if the proponent wishes to pursue the ocean dumping option for disposal of the sediments. Bioassay requirements consist of tests with the benthic amphipod *Rhepoxinius abronius* and a bioassay with either oyster larvae or echinoderm (usually sea urchin) larvae. The benthic amphipod test is used to determine the toxicity of the PAH-contaminated sediment, based both on mortality and on re-burying performance (17). The oyster or echinoderm larvae test is used to determine toxicity, based on mortality, as well as teratogenicity, as shown by production of larval deformities. It is usually the larval test that PAH-contaminated sediments fail to pass.

2. Halogenated Hydrocarbons

DDT and other organochlorine pesticides were widely used in Pacific Rim countries prior to the 1970s. DDT was banned in the USA, Canada and Japan, except for special purposes, e.g., malaria control, around 1970. It, along with other organochlorine pesticides, continued to be used on the Asian mainland until the early 1980s. HCH (hexachlorocyclohexane) and chlordane replaced DDT in Japan. Chlordane, largely used for termite control in Japanese homes, was eventually banned in 1987 because of its persistence, toxicity and the ecological damage that it causes. China banned the use of DDT and HCH for general purposes as recently as 1983 or 1984. Much of the residues of these compounds found in Japanese waters in recent times stemmed from China by way of long-range tropospheric wind transport (R. Tatsukawa, personal communication). China still uses DDT for special human health reasons, such as control of the spread of malaria by the mosquito. As the use of DDT was phased out in temperate latitudes, there was a shift in environmental contamination

by this insecticide to tropical areas, where it continued to be used to control the *Anopheles* mosquito as a vector for the malaria parasite (18). On the whole, however, DDT and its degradation products are exhibiting a decline in the North Pacific (Fig. 4) (19). HCH showed a similar pattern of decline in the seawater of the North Pacific from 1975 to 1985 (19).

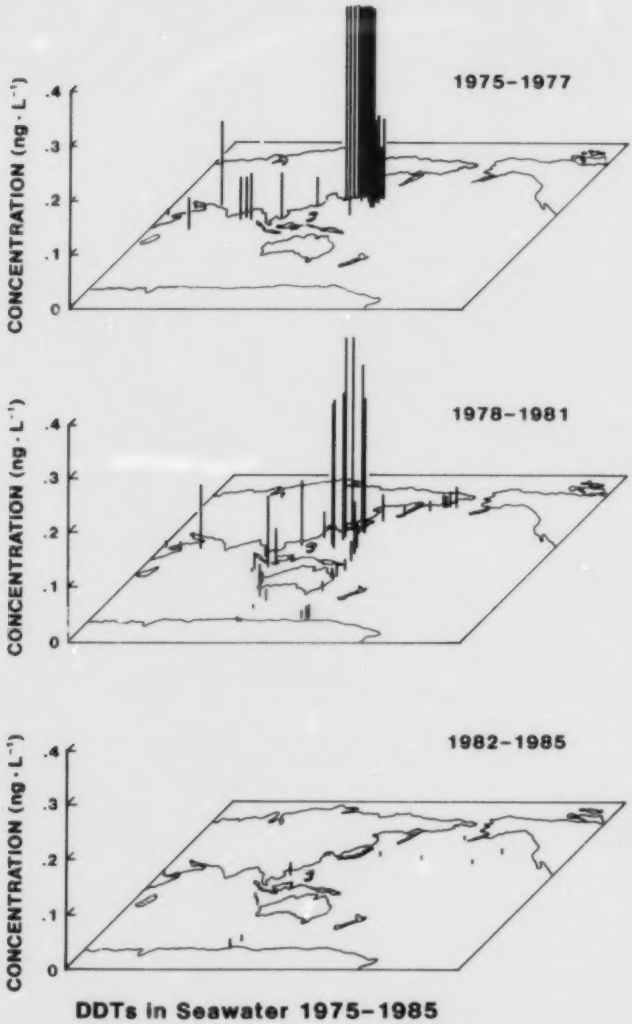

Figure 4. Changes in concentrations of DDTs in seawater of the Pacific and Indian Oceans from 1975 to 1985. [From Tatsukawa, unpublished data (19)].

Polychlorinated biphenyls (PCBs) are industrial chemicals of high stability and remarkable dielectric properties. For this reason, they have been widely used since the 1930s in electrical transformers and capacitors. Smaller amounts have been used in such applications as plasticizers, printing inks and as additives in lubricating oils. Because of the severe ecological hazards that they posed owing to their persistence and toxicity, PCBs were banned for minor applications and use in new equipment in most developed countries during the early 1970s. They continue to be used in older electrical equipment. PCBs drained from old electrical equipment taken out of commission have been often stored in drums in various warehouses, if there were no available means of destroying them. Drums with PCBs and old transformers and capacitors containing PCBs have leaked, and some have lost their contents in warehouse fires. PCBs continue to enter the environment in spite of restrictions on their use. For the Pacific Ocean as a whole, there has been a decline in PCB concentrations in seawater, as shown by the work of Japanese scientists (Fig. 5) (19).

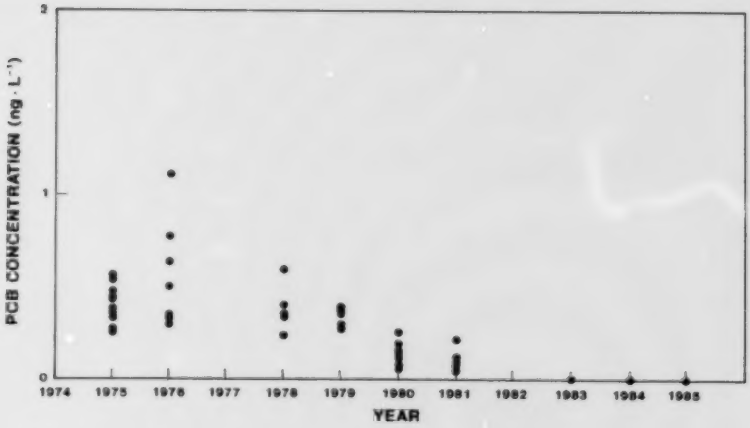

Figure 5. Trends in PCB residues in seawater of the Pacific and Indian Oceans, covering the area of 80°N-80°S, 40°E-100°W, during the period 1975-1985. [From Tatsukawa, unpublished data (19)].

PCBs continue to be found in marine organisms, particularly marine mammals, in areas far removed from industrial sources. Long-range atmospheric transport appears to be the mode for transfer of PCBs from terrestrial locations to distant places on the high seas. Japanese scientists note that co-planar PCBs, considered to be highly toxic, are present in the blubber of killer whales, *Orcinus orca*, and finless porpoise, *Neophocoena phocoenoides*, at great distances from the sources of these contaminants, and that they are obviously transported there by tropospheric winds (20).

A problem of marine contamination that has emerged on the coast of British Columbia in the last two years concerns polycholorodibenzo-p-dioxins (PCDDs) and polycholrinated dibenzofurans (PCDFs). These compounds have been found particularly in the vicinity of coastal pulpmills using chlorine for bleaching and led to extensive closures of crustacean fisheries in the vicinity of the mills (21). The main concern has been the presence of the highly toxic congener, 2,3,7,8-tetrachlorodibenzo-p-dioxin, in tissues, particularly the hepatopancreas, of crabs, prawns and shrimps. From results of animal tests with this dioxin, the Health Protection Branch of Health and Welfare Canada has derived a tolerance level of 20 ppt (parts per trillion), wet wt, for marine organisms used for human consumption. Based on a coastwide sampling program, the Department of Fisheries and Oceans closed the crab, prawn and shrimp fisheries in the vicinity of the two pulpmills in Howe Sound and for crabs in the vicinity of the Prince Rupert pulpmill on 30 November 1988. The closure was continued for all crustaceans and extended for crabs in Howe Sound on 14 June 1989, based on further testing (Fig. 6). Analyses of samples from other parts of the coast of British Columbia resulted in closures on 23 November 1989 of crustacean fisheries in the vicinity of most of the remaining coastal pulpmills and adjacent to a large coastal sawmill (Fig. 7). In nearly all cases, it was believed that the high levels of dioxins and furans originated from the reaction of chlorine used for bleaching pulp in pulpmills with phenolic organic compounds from the wood. In the one case where a sawmill was implicated, the high dioxin levels may have stemmed from the anti-sapstain treatment of lumber by tetrachlorophenol and/or pentachlorophenol, in which dioxins occur as impurities.

Dioxins and furans have undoubtedly been released by pulpmills since chlorine was first used for bleaching pulp and paper several decades ago. The question might be asked why these compounds have not been a problem until only recently. The answer has to be that it was only recently that our advanced analytical technology enabled us to measure dioxins and furans at the parts per trillion level. The pulp and paper industry in British Columbia has been required by the BC Ministry of Environment to reduce the discharge of chlorinated organics to a maximum of 2.5 kg per air-dry ton of pulp production by 31 December 1991 and to 1.5 kg by 31 December 1994. Many of the mills appear to be complying. The uneasy question is: How many other hazardous substances are being released by industry that we have not been looking for, or indeed, are still incapable of measuring?

3. Metals

Metals in the environment originate from a wide variety of natural sources, including weathering of metal-containing rocks and soils, volcanic eruptions and cosmic dust. Human activity adds metals to the environment through tilling the soil, mining operations, smelters, metallurgical plants, electroplating facilities, photographic laboratories, thermal-power-generating plants and combustion of lead-containing gasolines. The oceans contain metals originating from natural sources that have been entering the seas through river runoff

and the atmosphere since primordial time. Additional metals from human activity enter the marine environment by way of rivers, urban and agricultural runoff, municipal wastewater outfalls, ship discharges and via the atmosphere.

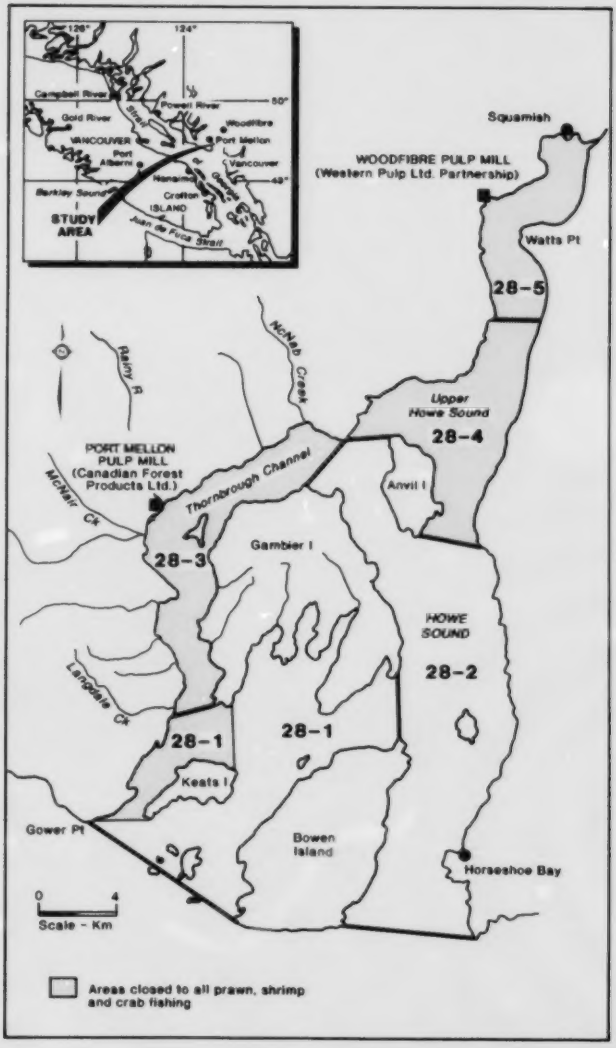

Figure 6. Areas in Howe Sound closed to harvesting crabs, prawns and shrimps due to high levels of dioxins and furans on 30 November 1988. Note: Fishing sub-area 28-1 was actually added for closure of shrimp and prawn harvesting on 14 June 1989. On that date also, all of Howe Sound was closed to commercial fishing of crabs.

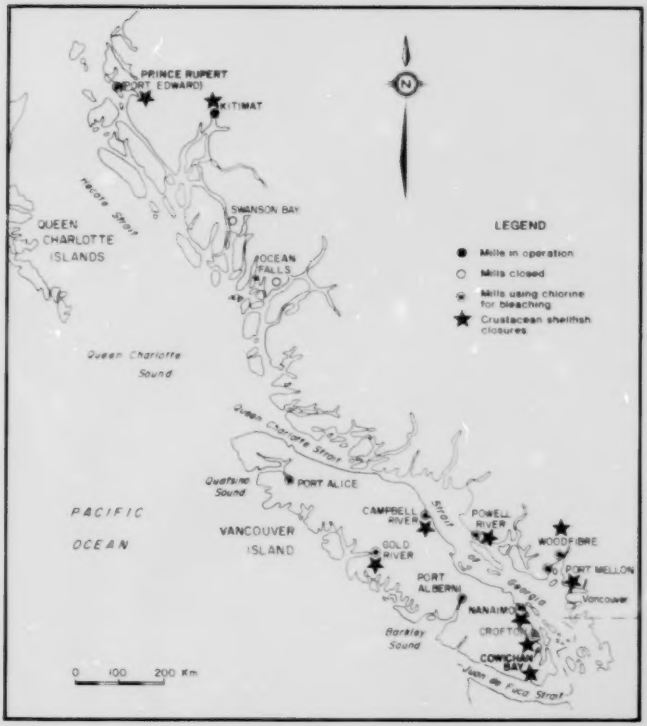

Figure 7. Map of the coast of British Columbia showing existing and closed pulpmills, mills using chlorine for bleaching and closures of fisheries for crustacean shellfish, 23 November 1989. Note: On 29 November 1990, extensions on shellfish closures in some of the areas were announced, but no new areas were closed.

While metals may appear in above-background concentrations in seawater of inshore areas, particularly where industry contributes metal-rich effluents, there is little evidence in the open ocean for concentrations of metals that exceed natural background levels by a significant margin. Many metals show an increasing concentration in seawater with depth (22). One exception to such a vertical distribution in seawater is lead, which has been shown to be present at substantially higher levels than background at the sea surface (23). This is presumed to be mainly due to atmospheric input of lead from automobile combustion of leaded fuels.

Metals tend to become adsorbed onto suspended organic and inorganic particulate matter in seawater and eventually settle to the bottom to become incorporated into the sediments as shown schematically in Figure 8 (24). Oxyhydroxide precipitates of manganese and iron may play an important role in scavenging other metals from the water column in areas where the man-

ganese and iron are present in high concentrations. In the sediments, where conditions are anoxic and hydrogen sulphide is present, most metals are firmly bound in the sulphide form; however, manganese may be released in the presence of hydrogen sulphide. Mobilizing of sediments by dredging or other stirring activity usually exposes the sediments to oxygenated water, which may result in some metals going into solution.

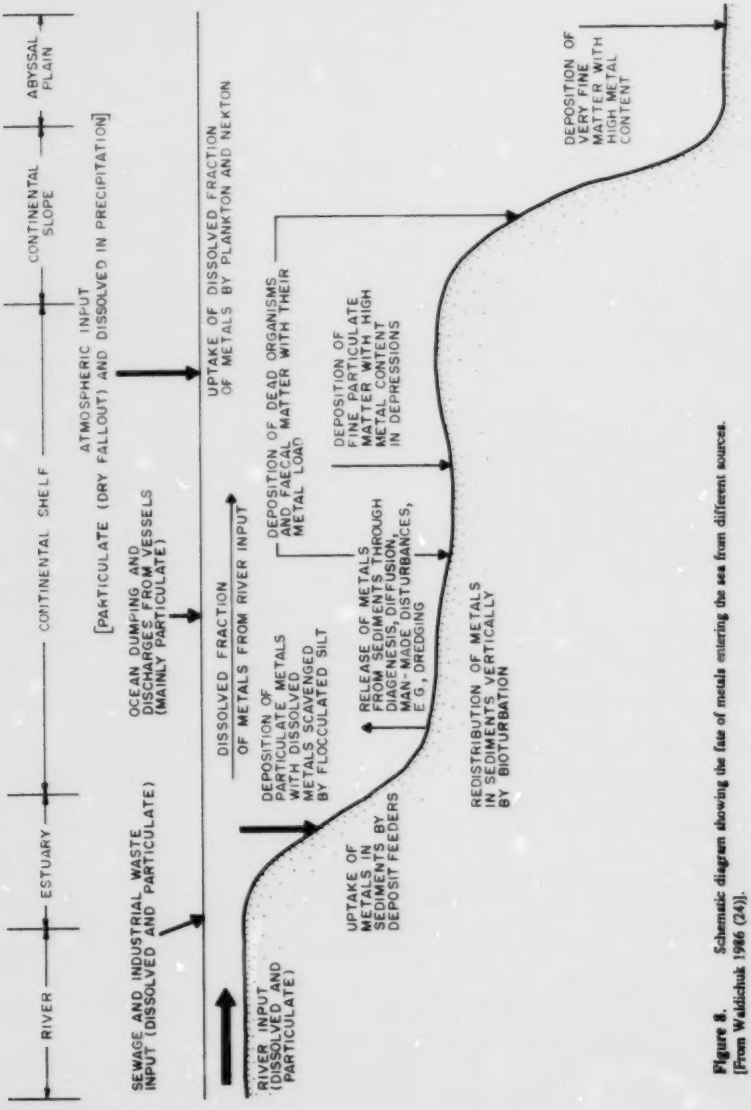

Figure 8. Schematic diagram showing the fate of metals entering the sea from different sources. [From Waldichuk 1986 (24)].

To be of consequence ecologically and a hazard to human health, metals must be biologically available (25). A large proportion of the total metals found in the marine environment does not enter into biological processes. Metals in the particulate form are essentially inert. Some of these "fixed" metals may go into solution when exposed to the acidic conditions in the gut of marine organisms when ingested. In general, metals present in seawater in the dissolved form are more likely than those in the particular form to have a biological effect on marine organisms and to be incorporated into their tissues.

One of the concerns about the disposal of mine tailings into the sea has been that metals leached from them are bioaccumulated by marine organisms. This certainly proved to be the case with metals dissolved from mine tailings deposited in a fjord on the northwest coast of Greenland (26). To determine the ecological and human health significance of disposal of mine tailings from the Island Copper Mine at Port Hardy into Rupert Inlet on the northwest coast of Vancouver Island, a review was undertaken in 1978 (27). Tailings are basically the pulverized waste rock from the ore after the desired metals have been extracted from it. The Island Copper Mine extracts mainly copper and molybdenum from the ore and disposes of about 50,000 tons of tailings daily into Rupert Inlet. Clearly, one of the issues to be considered was the release of such metals as copper and molybdenum from these tailings into the seawater and uptake by the marine organisms. Analyses of mussels and other invertebrates showed minimal bioaccumulation, except in the immediate vicinity of the concentrate-loading wharf.

An exposure experiment was conducted with the mussel, *Mytilus edulis*, and the mud clam, *Macoma balthica*, at different temperatures and salinities to determine the uptake of copper, zinc, cadmium, iron and lead from the Island Copper Mine tailings over a 30-day period (28). The exposure experiment included also tailings from the Nanisivik Mine on Baffin Island in the Northwest Territories, which disposes of its tailings into a lake draining into Strathcona Sound, and from the Greenex Mine on the northwest coast of Greenland where the tailings are discharged into Agfardlikavsâ Fjord. The results for lead (Fig. 9) (28) showed a comparatively low uptake of lead from tailings of the Island Copper Mine, with a very much higher uptake from tailings of the Greenex Mine (note that the concentration is given on a log scale), and an uptake from the Nanisivik Mine tailings that is only slightly higher than that for the Island Copper Mine tailings. It is obvious that the lead is more soluble, and hence more rapidly bioaccumulated, from the Greenex Mine tailings than in either the Island Copper or Nanisivik tailings.

Some metals, such as zinc, copper and iron, are required in small concentrations by marine plants and animals for their nutritional needs. Other metals, e.g., mercury, cadmium and lead, do not appear to play a role in plant and animal nutrition. When present in high enough concentrations, all metals are toxic to marine flora and fauna. Certain forms of metals are particularly toxic to humans. A good example of this is the methylated form of mercury that contributed so tragically to human fatalities and irreversible neurological disorders in the so-called Minamata disease in Japan (29).

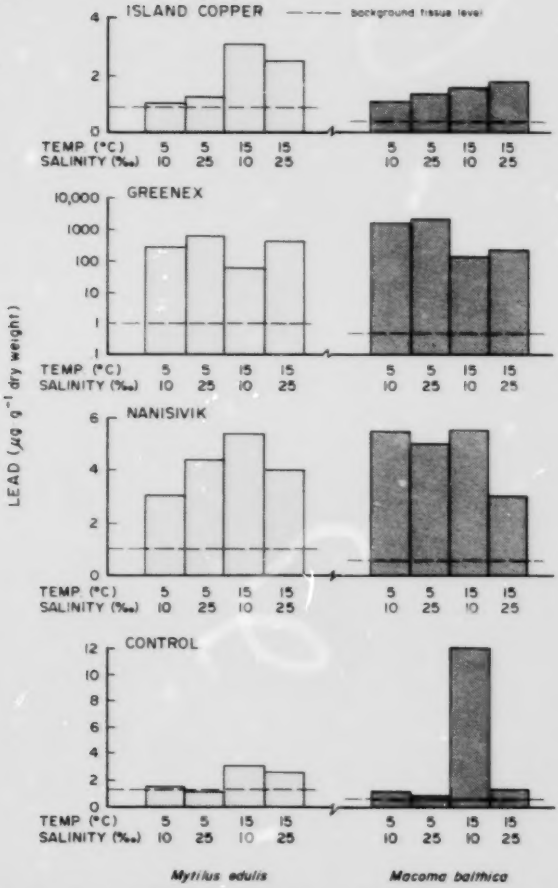

Figure 9. Uptake of lead from seawater exposed to different mine tailings by the bivalves, *Mytilus edulis* and *Macoma balthica*, at different salinities and temperatures. [From McGreer *et al.* 1980 (28)].

The problem of high mercury concentrations in aquatic organisms first arose in Canada in 1970, when high concentrations of mercury were found in freshwater fish downstream of chlor-alkali plants using mercury cells and adjacent to pulpmills using mercurial slimicides on the prairies and in Ontario. The Food and Drug Directorate of the Department of Health and Welfare Canada set a level of 0.5 ppm total mercury, wet wt, in fish muscle as the maximum permissible for marketed fish. Many tons of fish were confiscated. In British Columbia, pulpmills had voluntarily discontinued the use of mercurial slimicides around 1960, so that there was no evidence of mercury in fish from this source when surveys were conducted in 1970-71. However, mercury

was found in bottom fish and crabs in Howe Sound in waters adjacent to a chlor-alkali plant with a mercury cell in Squamish (30). The area was closed for harvesting these bottom species until reduction in the release of mercury from the chlor-alkali plant led to a lowering of mercury in the fish and invertebrates of Howe Sound.

Mercury concentrations higher than 0.5 ppm were also found in certain large specimens of long-lived species, such as dogfish, *Squalus acanthias*, ratfish, *Hydrolagus colliei*, and Pacific halibut, *Hippoglossus stenolepis*, and tuna (e.g. yellowfin, *Thunnus albacores*) (31) in the North Pacific far removed from anthropogenic sources of mercury. It soon became clear that the mercury accumulated by these species came from natural sources, and the concentration of mercury tended to increase with the age of the captured specimens.

The early use of mercury compounds to control slimes in coastal pulp and paper mills of British Columbia later led to problems of high mercury contamination in sediments adjacent to these mills. Disposal at sea of dredged material from these areas became regulated under the Ocean Dumping Control Act (ODCA) of 1975 (now Part VI of the Canadian Environmental Protection Act, as of 30 June 1988). The maximum permissible concentration of mercury in dredged material to be dumped at sea is 0.75 ppm, dry wt, and this was often exceeded in early dredging operations.

The discharge of pulpmill effluents containing excessive concentrations of zinc from the use of zinc dithionite (known as zinc hydrosulphite in the trade) for the brightening of groundwood used for newsprint in coastal mills of British Columbia resulted in high concentrations of zinc in nearby oysters (31). By 1973, the pulp and paper industry in British Columbia voluntarily decided to replace zinc dithionite with sodium dithionite as a brightening agent to reduce the zinc contamination of the molluscan shellfish. Although there has been no careful follow-up with monitoring of coastal oysters for zinc concentrations to determine the effect of reducing zinc releases from pulpmills, there has been no evidence from occasional sampling and analyses that zinc levels in oysters remain unusually high anywhere.

Prior to 1970, copper-based paints were widely used to protect the bottoms of ships and smaller vessels against fouling by algae and encrusting marine fauna. Such use raised concerns about the toxic effect of copper leached from these paints on nearby organisms in the marine environment. An effective replacement for copper was subsequently found in tributyl tin (TBT) for anti-fouling paints. The new organo-metallic additive became widely used in paints not only for the bottoms of boats, but also for anti-fouling treatment of nets in fish pens used for holding fish in aquaculture. TBT was soon found to have highly undesirable effects on oysters and other marine species. It led to a significant reduction in reproductive success in oysters (32), and to shell thickening in adult oysters that rendered them unmarketable for the halfshell trade. Residues of TBT were also found in salmon held in pens with TBT-treated nets (33).

Tributyl tin is now either banned or restricted in several countries, including France, Canada and the U.S.A., for use as an anti-fouling additive for paints

applied to hulls of boats and nets of fish pens. The most common restrictive measures on the use of TBT-based paints is that they must not be used on vessels smaller than 25 m in length and on mariculture structures. But they continue to be used on vessels longer than 25 m, and the problem of marine contamination is considered serious enough internationally that it has been taken up for review by the Marine Environment Protection Committee of the International Maritime Organization. A problem identified by the Consultative Meeting of Contracting Parties to the London Dumping Convention is the potential hazard caused by disposal at sea of dredged material from marinas, shipyards and ship-repair depots containing high levels of organotin compounds. A suitable, universally acceptable replacement for TBT as an antifouling agent has not yet been found, but there is a move in some quarters back to copper-based paints.

The foregoing deals with coastal, inshore problems of contamination by metals. Aside from the surface contamination of offshore waters by lead, there is little evidence of anthropogenic sources of metals in the open North Pacific. A review by GESAMP (34) shows that mercury concentrations in ocean waters range from 0.37 to 7.0 $ng.L^{-1}$, although representative levels are about 1 $ng.L^{-1}$. On the basis of the available data, there does not appear to be a distinctive distribution of mercury with depth in the oceans. Mercury concentrations in the northeast Pacific are about one-half of those in the northwest Atlantic. There is some evidence that mercury concentrations decrease along a north-south gradient, possibly as a result of higher atmospheric transport from the Asian continent in the northern sector and deposition via rain.

Unlike mercury, cadmium, exhibits a nutrient-like distribution in the oceanic water column, concentrations being low at the surface and increasing with depth. Surface concentrations range from 0.2 to 200 $ng.L^{-1}$, with the lowest (up to 10 $ng.L^{-1}$) being found in the open North Pacific. The higher inshore values in the North Pacific have been attributed to upwelling (34).

The concentrations of lead in the North Pacific range from 5 to 50 $ng.L^{-1}$ in surface samples (Fig. 10) (23). The vertical distribution of lead differs from that of cadmium; surface concentrations of lead are about 10 times greater than those in deep water, which are usually around 1 $ng.L^{-1}$ (23) (Fig. 10). The high sea-surface lead levels are attributed mainly to atmospheric inputs arising from combustion of leaded gasoline and emissions from smelters. The highest fluxes of lead from the atmosphere to the North Pacific occur in the vicinity of China and Japan (1).

It has been suggested from available data (34) that mercury and cadmium in the open ocean are derived for the most part from natural sources such as rock weathering or sea-bed eruptions; but lead distributions in coastal and open-ocean areas have been significantly affected by anthropogenic sources.

With the reduction of lead in gasoline, imposed by regulations, there is evidence for a decline in lead concentration in such major streams as the Mississippi River (35), as well as in the marine environment, as suggested by corals off the southeastern U.S.A. A two-fold decline in fluxes of eolian lead inputs to North Atlantic surface waters during 1970 to 1980 has shown up in

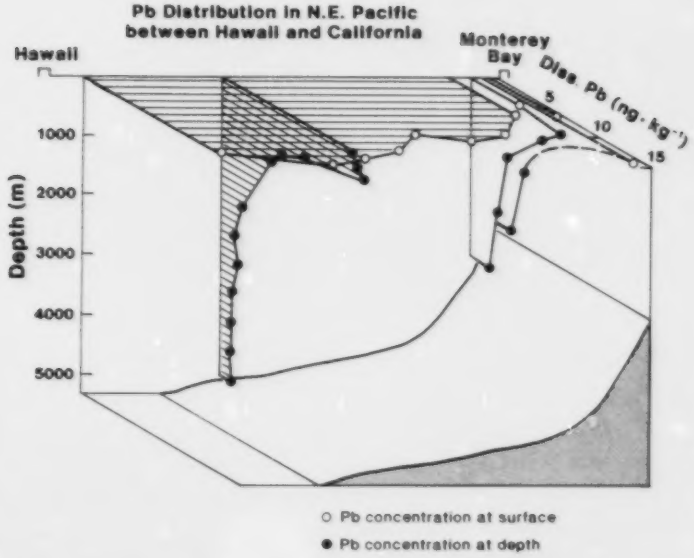

Figure 10. Dissolved lead distribution in seawater of the Northeast Pacific Ocean. [From Schaule and Patterson 1980 (23)].

coral growth layers, and this is probably associated with the decrease in alkyl lead combustion in the U.S.A. (36). A comparable reduction in flux of lead from the atmosphere to the oceans has probably occurred also in the eastern North Pacific, as a result of North American curtailment of leaded fuels, but any marine evidence for such curtailment in Asiatic countries is not yet available.

4. Radionuclides

The oceans contain radioactive elements derived mainly from natural sources. To these are added a relatively small quantity from artificial inputs. Radioisotopes of potassium, rubidium, thorium and uranium, and the radioactive disintegration products of thorium and uranium constitute the bulk of the natural radionuclides in the marine environment. They enter the oceans as a result of runoff from weathered rocks, or in the case of disintegration products, by decay of the parent radionuclides in the water itself. Carbon-14 and tritium (^{3}H) originate from the atmosphere through the interaction of cosmic radiation from outer space and constituents present in air; they can also be produced through human activities. These cosmogenic radionuclides are deposited on the sea surface by precipitation. Both groups of radionuclides are distributed vertically through the water column by physical, chemical and biological processes, and horizontally mainly by currents. They are eventually deposited in the ocean sediments. The inventories of ^{14}C, ^{3}H, ^{40}K and ^{238}U in

the global ocean waters have been estimated to be 8.0×10^3, 8.5×10^2, 1.6×10^7 and 5.6×10^4 PBq (petabecquerels), respectively (34).

The main source of artificial radionuclides globally has been dry fallout and wet deposition from atmospheric and sub-sea nuclear weapons tests from 1945 to 1963 (37). Radionuclides produced by these tests included ^{14}C, ^{3}H, ^{137}Cs and ^{90}Sr, as well as plutonium and other transuranic elements. The estimated global inputs were 6.1×10^2, 1.5×10^5, 8.2 and 3.7×10^2 PBq for ^{137}Cs, ^{3}H, $^{239,240}Pu$ and ^{90}Sr, respectively, and at least 40 PBq for ^{14}C (34).

Since Partial Test Ban Treaty of 1963, which prohibited atmospheric and sub-sea testing of nuclear weapons by the signatory nations (major nuclear powers), there has been a steady decline in the concentrations of artificial radionuclides in the marine environment, as exemplified by ^{137}Cs and ^{90}Sr in the surface water of the North Pacific (Fig. 11) (38). The comparatively high concentrations observed from 1957 to 1959 were apparently a result of a large series of hydrogen bomb explosions, the so-called Castle Test, conducted by the U.S.A. on the ground surface of the Bikini-Eniwetak atolls in the tropical Pacific during March-May 1954. The widespread dispersals of fallout radionuclides has led to low-level ambient concentrations which add a negligible increment to the exposure from natural background.

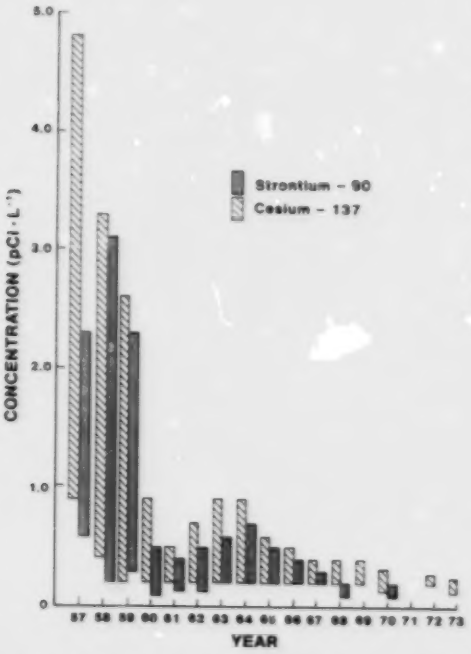

Figure 11. Variations in ranges of strontium-90 and cesium-137 concentrations in the western North Pacific Ocean, from 1957 to 1973. [From Miyake *et al.* 1978 (39)].

While nuclear reactors provide some local environmental input of radionuclides, they have not made significant global contributions of radioactivity when operating normally and discharging under regulatory controls. The Chernobyl, U.S.S.R., disaster of April 1986 contributed a globally significant amount of radionuclides, but this addition was comparatively short-lived. There was widespread contamination of the environment throughout Europe. Exposure of the population was mainly from gamma emitters on the ground and from ^{137}Cs in dairy and meat products. The deposition of ^{137}Cs in the oceans was estimated to be 4.7 PBq out of a total of 70 PBq released (34). No effects on marine organisms were reported, and the exposure of people as a result of consumption of seafood contaminated by radionuclides from the Chernobyl accident was negligible.

Few modern nuclear reactors discharge effluents directly into the aquatic environment. Older nuclear installations, in some cases, discharged cooling waters. One of the reactor complexes of this type on the Pacific Rim is the Hanford Works on the Columbia River in eastern Washington State, U.S.A. This was a World War II facility where much of the plutonium for nuclear weapons was produced. Eight of the nuclear power reactors, which contributed much of the chromium-51 and other radioactive contamination in the Columbia River, were closed down in 1971. There is only one power reactor and a research reactor remaining in operation at Hanford (39). The radioactive contributions from these two reactors to the Columbia River, its estuary and to the North Pacific are now very small. The river is monitored for radionuclides near the Hanford works, but not in the estuary nor in the Pacific Ocean beyond the estuary.

Disposal of low-level radioactive wastes in packaged form took place off the coast of California in the 1940s and 1950s (40). This was phased out in the early 1960s, primarily because of high costs of transporting the wastes out to sea. Canada has never officially disposed of radioactive materials at sea. Comparatively small low-level radioactive waste dumping operations were carried out at sea by Japan between 1965 and 1968 and by the Republic of Korea between 1968 and 1972. The total amount of radioactive material dumped at sea worldwide, estimated at 60 PBq, is much less than the approximately 2×10^5 PBq that were added to the oceans as a result of nuclear testing of weapons from 1954 to 1962, which in turn, is only 1 per cent of the 2×10^7 PBq that exist naturally in the oceans. What has to be borne in mind, of course, is that the mix of radionuclides involved in each case is different, and effects that they have on marine organisms and man may vary widely.

The total amount of artificial radionuclides entering the North Pacific from nuclear reactors, reprocessing of nuclear fuel, industrial and medical uses, the manufacture and operation of military nuclear equipment, as well as the operation of nuclear-powered ships, is difficult to assess. But it seems abundantly clear that in the absence of a resumption of atmospheric nuclear testing or actual utilization of nuclear weapons in warfare, the level of radioactivity in the North Pacific is not expected to increase significantly.

5. Persistent Solids

Like other areas of the world oceans, the North Pacific has received its fair share of waste in the form of solid matter. An early perceived problem concerned plastic litter and its accumulation on beaches (41,42). The potential ecological impact and effect on fishing and small vessels of persistent plastics in the marine environment was considered serious enough to prohibit them from being dumped into the sea in the first regional dumping convention (43), and in the global dumping convention (44). Other regional conventions have subsequently followed suit.

In the North Pacific specifically, the effects of discarded fish netting and other persistent plastics on the North Pacific Fur seal, *Callorhinus ursinus*, were considered to be a serious problem and began to receive attention from the North Pacific Fur Seal Commission in the early 1970s (45). The percentage of harvested seals entangled in nets on St. Paul and St. George Islands increased steadily from 0.17 per cent in 1967 to 0.47 per cent in 1973 (46).

The effects of marine debris on the northern fur seal from 1965 to 1985 have been evaluated by Fowler of the US National Marine Fisheries Service (47,48). Although a small number of this species had been observed with various objects caught around their necks, shoulders and flippers since the early 1930s, it was not until the mid-1960s that the incidence of such entanglement increased. The recent incidence of entanglement is 0.4 per cent, which is about two orders of magnitude higher than that observed in the 1940s. This increase was attributed to greater fishing efforts in the North Pacific and Bering Sea, and initiation of extensive use of plastic materials in trawl netting and packing bands. The percentage entanglement of sub-adult male fur seals in St. Paul Island, Alaska, for 1960-1985 is shown in Figure 12 (48). The peak entanglement rate occurred in 1974 and 1975 and has generally declined since then.

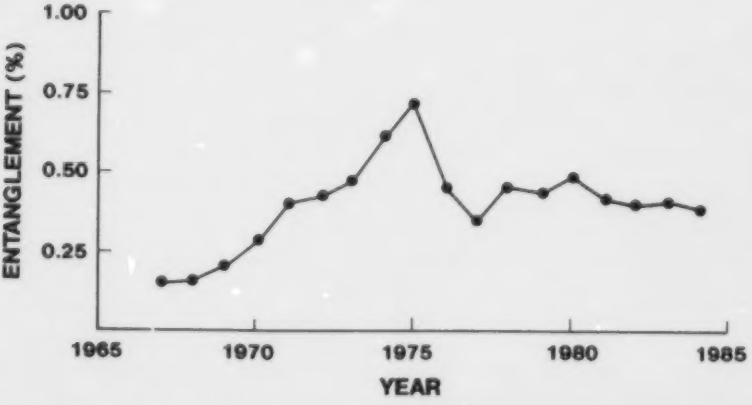

Figure 12. The entanglement rate observed in the harvest and research drives of sub-adult male fur seals for St. Paul Island, Alaska, 1960-1985. [From Fowler 1987 (48)].

Fowler (48) considered that entanglement-caused mortality may be the principal reason for the recent decline in the fur seal population on the Pribilof Islands. The annual percentage change in the estimated numbers of fur seal pups is correlated with the entanglement rates observed six years earlier (Fig. 13) (48). The approximate rate of recruitment to the female breeding population is six years. The rate of decline following 1980 was somewhat less than earlier, corresponding to a reduced rate of entanglement of about 0.4 per cent.

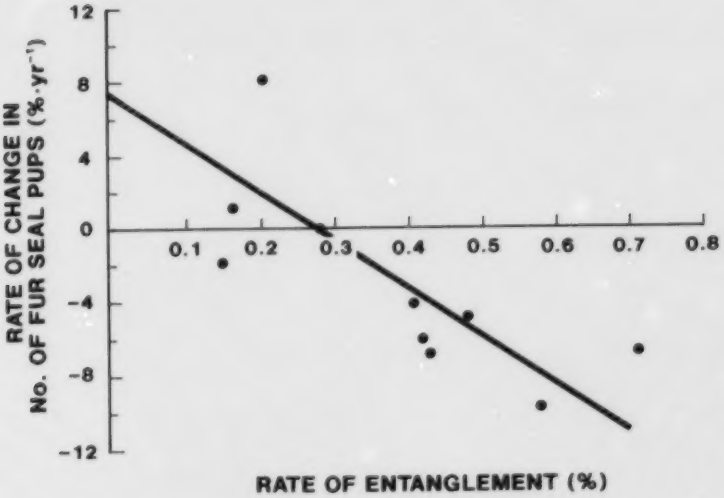

Figure 13. The correlation between the rate of change in estimated numbers of fur seal pups and the per cent of juvenile males observed entangled six years earlier, 1967-1977. [From Fowler 1987 (48)].

The density and distribution of plastic material in the North Pacific are being determined, using visual observations and neuston net tows, by investigators at the US National Marine Fisheries Service in Auke Bay, Alaska, and Seattle, Washington, and at the University of Alaska in Fairbanks and the University of Washington in Seattle (49,50,51,52,53,54). The distribution and abundance of pelagic plastic and tar in the subtropical and subarctic North Pacific and Bering Sea were determined in June-August 1985 and compared with similar observations in the same areas in 1976 and 1984 (53). The larger plastic objects of about 2.5 cm in diameter and greater were counted from the deck of a ship, while the smaller plastic material and tar balls were taken with a neuston net. The densities of large plastic materials, in number of items per m^2, in subtropical waters averaged twice those in subarctic waters and eight

times those in the Bering Sea. In subtropical waters, the concentrations (mg m^{-2}) of small plastic and tar averaged twenty-six and three times those in subarctic waters, respectively. Small plastic concentrations were 400 times as high in subtropical waters as in the Bering Sea; no tar was found in waters of the latter. Densities of large plastic along longitude 155°W did not differ much between 1984 and 1985 (Fig. 14) (53). Concentrations of small plastic, however, increased significantly from 1976 (surveyed along longitude 158°W) to 1985 (surveyed along longitude 155°W). There was a decrease, but not significant, in tar concentrations between 1976 and 1985. This may have been due to a reduction in the annual amount of petroleum hydrocarbons dumped into the sea during this period.

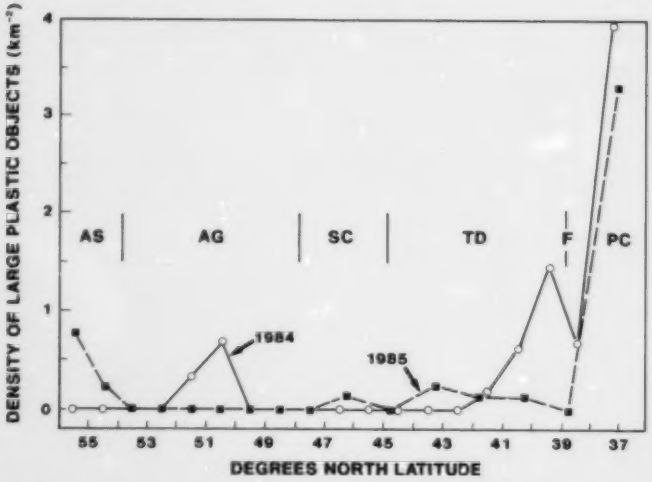

Figure 14. Comparison of densities of large plastic along 155°W in 1984 and 1985. [From Day and Shaw 1987 (53)]. [AS = Alaskan Stream; AG = Alaskan Gyre; SC = Subarctic Current; TD = Transitional Domain; F = Subarctic Front; and PC = North Pacific Central Water]

The really serious problems of entanglement of birds and mammals and "ghost fishing" arise from discarded and lost fishing nets at sea. This particularly includes the driftnets, made of plastic monofilament line, which are being used on the high seas in increasing numbers. It has been estimated that there were 1,700 driftnet vessels in the North Pacific at any one time during the summer squid-fishing season of 1987, with a total of 30,000 km of driftnets, 7.0 m deep, floating freely. If only 1 per cent of those driftnets is lost or discarded, then there would be 300 km of fugitive driftnets on the high seas entangling birds, mammals and sea turtles. They continue to fish unattended in what is commonly called "ghost fishing". One net recovered from the North Pacific Ocean contained 99 dead seabirds and more than 200 dead salmon (55).

It is estimated that globally 23,000 tons of plastic packaging and 135,000 tons of plastic nets, lines and buoys enter the sea from commercial fishing operations (56). A global assessment of entanglement by such debris is difficult to make, but one report (55) estimated that 2 million seabirds and 100,000 marine mammals die every year after eating or becoming entangled in debris.

No accurate assessment has been made of the magnitude of the debris problem caused by such materials as fugitive driftnets. A recent report by a Japanese investigator (57) discussed sighting surveys on marine debris conducted in the mid-western Pacific during the summer and winter from 1977 through 1986. The amount of marine debris, although it fluctuated from year to year, tended to increase during the period of the surveys. The density of marine debris was higher in summer than in winter, and was higher in areas north of 20°N latitude than to the south. The concentration of marine debris was also higher in coastal areas east of Japan, west of North America, north of Hawaii and in the East China Sea and the Bering Sea, than in the open Pacific Ocean.

Mio and Takeham (58) reported results of a marine debris sighting survey under the auspices of the Fisheries Agency of Japan, conducted by 20 vessels, covering a distance of nearly 150,000 km in the North Pacific, during the period June-December 1986. The debris censused was that which was large enough to be visible to the naked eye. Binoculars were only used to identify the objects. Only the number of the debris items was taken into account in the analysis, not the size. The categories of marine debris recorded were: net gear (trawl net, driftnet, unidentified net), other fishing gear (including packaging material for fishing gear), plastic bands, other plastic articles, styrofoam, drifting logs or other pieces of wood, drifting seaweed and other drifting material. Of the total debris sighted, 59 per cent were plastic items, including fishing gear. A high density of debris was found in coastal waters, particularly along the Japanese coast, as well as along the North American continent, and in waters of the east China Sea, Bering Sea and northwest of the Hawaiian Islands. The fishing gear categories exhibited high densities in some areas of the central North Pacific, as well as in coastal waters.

Since there is no evidence that active fishing operations occur in the central North Pacific, it was presumed that most net gear and other gear debris had converged in this area by being transported there from surrounding areas. The large-scale clockwise circulation (North Pacific Gyre) arises from the Juroshio, Kuroshio Extension, North Pacific Current, California Current and North Equatorial Current. The area northwest of the Hawaiian Islands lies almost at the centre of this large-scale circulation, and it is here where much of the net gear and other gear debris was concentrated. It has been hypothesized (58) that the marine debris in offshore areas of the north Pacific moves eastward in the latitude range of approximately 40° to 50°N, then moves southward off the US west coast merging with debris from US coastal waters, and finally converging in the area bounded by the coordinates 28° to 40°N, 160° to 170°W, northwest of the Hawaiian Islands.

Entanglement by marine debris may not have a serious impact on populations of species that are present in large abundance, such as the stocks of commercially exploited fish. But the effect on endangered species may be highly significant. There is concern in the North Pacific that entanglement in synthetic fish netting and ropes could lead to further declines in such endangered species as the Hawaiian monk seal, *Monachus schauinslandi* (59,60,61). Through to 1984, thirty-five incidents of monk seal entanglement have been documented in Hawaii (60), including eight seals bearing scars indicative of entanglement from which the animal had escaped. In the two-year period 1983-1984, eight incidents were noted. From 1985 to 1987, nineteen monk seals were observed entangled, including three that were dead, or bearing new scars from recent entanglements. This incidence of nineteen entanglements over three years represents an increase from 4.0 per year during 1983-1984 to 6.3 per year during 1985-1987. This increase has occurred in spite of the fact that the beaches of the Northwestern Hawaiian Islands, where the monk seals are found, are cleaned at least annually of debris that might entangle marine animals.

Investigations of sea turtle entanglements have revealed twenty-five incidents of such entanglements through 1984, including twenty green turtles, *Chelonia mydas*, four olive ridley turtles, *Lepidochelys olivacea*, and one hawsbill turtle, *Eretmochelys imbricata* (62). It was believed that the animals became entangled in drifting scraps of fishing gear in their normal range to the south of Hawaii and then passively drifted northward (61). Incidents of leatherback turtle, *Dermochelys coriacea*, fatally entangled in pieces of monofilament mesh, have been recorded in the North Pacific at latitudes from 35°N to 45°N (62). As in many cases involving marine turtles, however, it is unclear if entanglement occurred in discarded net fragments or in intact gear being actively fished. In addition to entanglement, sea turtles eat at a wide array of synthetic drift items, including styrofoam beads, monofilament fishing line and plastic bags, which resemble jellyfish, a favourite food item. Physical obstruction of the digestive tract is one of the potentially adverse effects of such ingestion.

Other endangered species, which could conceivably be adversely affected by entanglement with marine debris, include the sea otter *Enhydra lutris*, which was last seen in nature on the coast of British Columbia in 1929 and was reintroduced from Alaska in 1969 and 1971. Although no incidents of entanglement have been reported, it is conceivable that these marine mammals could also suffer from the presence of synthetic netting and ropes in their habitat.

It has been estimated in a US National Academy of Sciences study, published in 1975 (63), that 14.0×10^6 kg of trash were discharged from ships annually, based on average ship sightings by the US Department of Defence in 1964. Although high-seas disposal of ship-generated garbage has been commonplace, this may be curbed in future with the entry into force on 31 December 1988 of Annex V of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating

thereto (MARPOL 73/78) (64). This Annex prevents pollution by the dumping of garbage, which includes all kinds of victual, domestic and operational waste generated during the normal operation of a ship. An important provision of Annex V is a ban on the dumping into the sea of all plastics, such as synthetic ropes, synthetic fishing nets and plastic garbage bags. The Contracting Parties to the Convention are obliged to provide facilities in ports for the reception of garbage. The Annex is supposed to apply to all kinds of vessels. It is uncertain, however, how the terms of the Annex will be implemented and enforced with fishing vessels and recreational craft. It is more likely that an educational program for operators of fishing boats and recreational vessels will be more effective in stemming the disposal of refuse from these craft at sea.

DOMESTIC POLLUTION

While industrial wastes may cause serious local pollution problems in industrialized coastal areas, domestic sewage is more pervasive and widespread in coastal waters of countries bordering on the North Pacific. Sewage has led to ecological, human health and aesthetic problems, particularly along the heavily populated coast of Asia. The effects of sewage are confined generally to nearshore coastal waters, but unfortunately, this is where seawater and beaches are used for recreational purposes. The examples used in this section to illustrate the effects of sewage on marine resources are taken mainly from investigations on the Pacific coast of Canada, with some reference to studies in Japan, China and Hong Kong. The pollution problems due to sewage in US Pacific coastal waters are similar to those in Pacific Canada. It is clear that problems of sewage pollution along the Asiatic coast are much more severe than along the North American coast, because of the higher population density. This becomes evident as one examines some of the effects of sewage in detail.

Domestic sewage, sometimes referred to as sanitary wastes, consists of human excreta along with a host of household discharges, such as kitchen sink washwaters, garburator grindings and laundry effluents. Metals may enter domestic sewage as corrosion products or leachates from the piping, but normally, this is a small source of contamination. What are much more significant sources of contaminants that enter municipal wastewater are wastes from hopitals, dental offices, photographic processing facilities, industrial laboratories, commercial establishments and small-scale industries. These additional wastes often contain substances that are quite toxic, persistent and subject to bioaccumulation in the marine environment. The following discussion will be confined to sewage *per se* and not to the added substances from other sources.

The effects of sewage in the marine environment are schematically depicted by a block diagram shown in Figure 15 (66). In cases where large volumes of untreated sewage are discharged into coastal waters, which are not rapidly replaced, the principal effects are turbidity in the water, floatables on the water surface, deposition of the solid fraction in sludge beds, depletion of dissolved oxygen in the water sediments, and high bacterial concentrations in

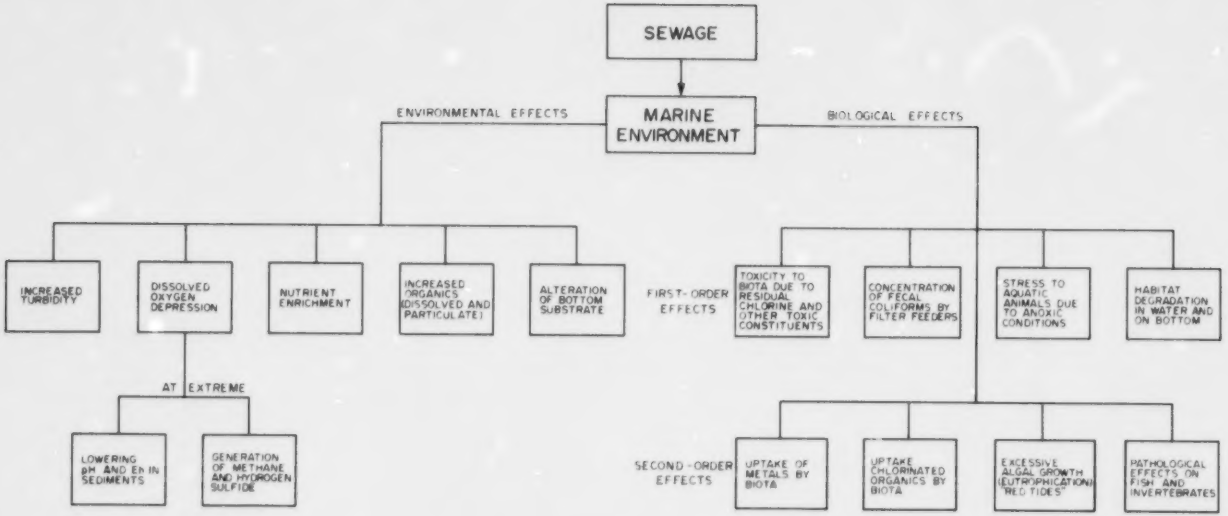

Figure 15. Block diagram schematically showing the environmental and biological effects of sewage in the marine environment. [From Waldichuk 1988 (66)].

the water and sediments. In a situation with a heavy loading of sewage, there may eventually be excessive algal growth leading to a state of eutrophication or even red tides.

The degree of treatment applied to sewage before discharge into nearby waters will determine the intensity and extent of pollution caused by the sewage effluent. The most rudimentary form of treatment is removal of the floatable substances by screening and breaking up of the heavier solids by grinding (comminution), which is referred to as physical treatment. The next degree of improvement is known as primary treatment, and it involves removal of all the solids by screening and settling. The effluent is usually released without further treatment, but it may be disinfected by chlorination if the situation demands it. Most of the sewage discharged into coastal waters of British Columbia undergoes primary treatment. Secondary treatment provides a much higher degree of removal of solids and dissolved constituents than primary. Filtration, coagulation, aeration and possibly disinfection are all involved in secondary treatment. The final form of treatment is tertiary, which constitutes removal of nutrients by chemical or biological means. Secondary and tertiary treatment are usually reserved for situations where the effluent is discharged into freshwater systems. In lakes where europhication is a problem, tertiary treatment may be recommended for any sewage to be discharged.

1. Bacterial Contamination

One of the more serious pollution problems associated with sewage is a high concentration of microorganisms in the water. These may be bacteria and viruses that stem from the human intestinal tract. Some may be pathogenic. The conventional indicator organism that is used to measure the quality of water in relation to sewage contamination is the fecal coliform. While it is not specific to human excrement, the fecal coliform concentration has been found to be reasonably representative of the concentrations of bacterial flora and viruses found in human sewage. It is used to determine whether waters are suitable for shellfish harvesting and/or for bathing.

(a) Shellfish waters

Shellfish, particularly oysters, may be eaten raw or partially cooked, and the presence of bacteria or viruses poses a health hazard to the consumer. Therefore, regulations have been developed to ensure that shellfish harvested from Canadian coastal waters are safe for human consumption. The Canadian Shellfish Sanitation Program, administered jointly by Environment Canada and the Department of Fisheries and Oceans, requires that all shellfish growing areas be approved prior to the shellfish being harvested for marketing. Environment Canada carries out sanitary and bacteriological water quality surveys to identify and evaluate all potential sources of pollution to shellfish growing and harvesting waters. The shellfish growing areas are then classified, based on the results of these surveys, as to their suitability for the harvesting of shellfish, according to the accepted criteria established by the National Shellfish Sanitation Program (66). The Department of Fisheries and Oceans

implements and enforces shellfish closures under the Pacific Shellfish regulations of the Fisheries Act. With respect to sewage contamination, the regulation states that an approved shellfish area requires that "the median Most Probable Number (MPN) of fecal coliforms in water should not exceed 14 per 100 ml. and no more than 10 per cent of samples should exceed 43 per 100 ml, for a five tube decimal dilution test."

The shellfish closures due to high fecal coliform counts in the water on the southern coast of British Columbia are shown in Figure 16 (3). Not all the closures are due to domestic sewage. Some of the high coliform counts have arisen from urban and agricultural runoff as well as from recreational vessels. A large proportion (70%) of the closed area is represented by Boundary Bay, the Fraser River estuary and Vancouver Harbour, where there is a mixed input of fecal coliforms from domestic sewage and urban and agricultural runoff. Some areas on the west coast of Vancouver Island are relatively uninhabited by humans, yet the fecal coliform levels are high. This is largely due to wildlife that contributes fecal matter to the watershed. Even an influx of sea lions to a particular area during certain periods of the year is accompanied by an increase in fecal coliforms (B.H. Kay, personal communication).

Figure 16. Areas of shellfish closures in waters of the south coast of British Columbia due to high bacterial counts. [From Kay 1989 (3)].

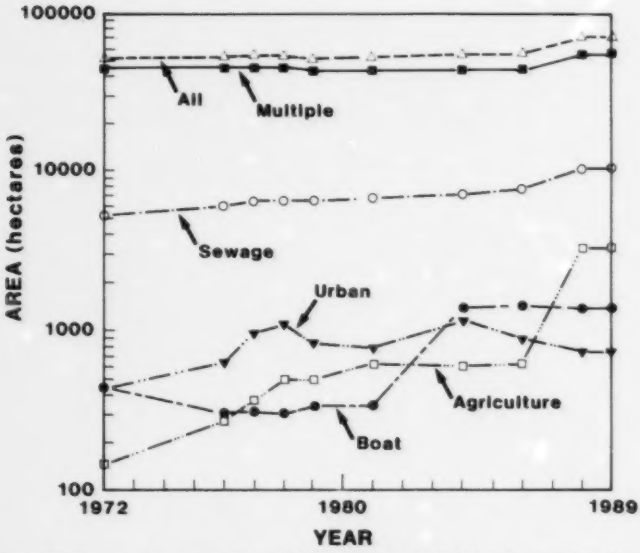

Figure 17. Trends in areas of shellfish closures in British Columbia from 1972 to 1989. [From Kay, unpublished data (68)].

The trends in the number of shellfish closures, due to high fecal coliform counts in the water, on the coast of British Columbia from 1972 to 1989 are shown in Figure 17 (68). An effort has been made to separate out the various causes of high coliform counts, including urban and agricultural runoff, boat discharges, as well as sewage fallouts. In many cases, there is a combination of sources, and these account for the largest area of closures. Sewage outfalls constitute the largest area of closures. There has been a gradual increase in total closures throughout the period of surveys, with a substantial jump from 1986 to 1988. This recent rise is not necessarily due to worsening conditions but is more likely a reflection of an increasing number of bacteriological surveys in new areas where shellfish are being harvested, particularly on the west coast of Vancouver Island. Municipal discharges have been implicated as a major contributing source in approximately 25 per cent of the bacteria-contaminated areas and a minor source in a further 25 per cent of such areas. Major contributions of coliforms and other contaminants come from other sources.

The overall increase in closed shellfish growing areas since 1972 has been only about 1 per cent. If closures in the highly urbanized areas of Vancouver and Victoria are excluded, there has been an actual 8 per cent decrease in the total shellfish-growing area under closure (3). The decrease can be attributed primarily to re-opening of portions of Ladysmith Harbour following improvements in sewage collection and treatment in Ladysmith, re-opening of Parksville Bay subsequent to the construction of the French Creek treatment

plant and outfall, and partial re-opening of the Nanaimo Harbour area following closure of the raw sewage discharge at the shallow Newcastle Island outfall and installation of a new treatment plant in Hammond Bay and a deep outfall at Five Finger Islands.

At the end of 1989, the total area of shellfish closures in British Columbia due to high coliform counts was 70,993 hectares, which was made up of areas closed due to imputs from the following sources: multiple, 55,231 hectares; sewage, 10,349 hectares; urban runoff, 753 hectares; agricultural/hinterland runoff, 3,285 hectares; and boat discharges, 1,375 hectares. These closures covered approximately 760 km of coastline. There were 156 shellfish closures in British Columbia to April 1990, some of which were seasonal.

Whether the trends in treatment and outfall design for sewage disposal into coastal waters of British Columbia will lead to further bacteriological improvement of shellfish growing waters is uncertain. The most rapid increase in the total number of permits issued for municipal wastewater discharges has been for sewage receiving primary treatment (3). A substantial increase has also occurred in permits issued for discharges from secondary treatment. There has been little increase in permits for discharges of raw sewage or sewage receiving physical treatment (screening and comminution).The trend in British Columbia has also been to ocean outfalls that are deeper and further from shore, with a higher degree of dispersion through diffusers, for sewage effluent from all forms of treatment. This trend is true also for sewage outfalls along the US Pacific coast, with the additional proviso that secondary treatment is mandatory for sewage discharge at coastal outfalls, unless a waiver from this requirement is obtained.

(b) Bathing waters

Coastal recreational waters in British Columbia are monitored for bacteriological levels as a protection for those engaged in water-contact sports. This is done by municipal and provincial public health officials under the British Columbia Health Act. For example, at beaches in the Greater Vancouver area, the medical health officer of the City of Vancouver Health Department is responsible for the safety of bathers in waters of Vancouver beaches against health hazards. The Greater Vancouver Regional District takes samples of water at bathing beaches during the bathing season and analyses them for fecal coliforms.

For bathing beaches, medical health officers apply an objective or guideline of: "The geometric mean of not less than 5 samples taken over a 30-day period should be less than 200 fecal coliforms per 100 ml. Resampling should be performed when any sample exceeds 400 fecal coliforms per 100 ml", in accordance with the Guidelines for Canadian Recreational Water Quality (1983) (68). Beaches which exceed the 200 fecal coliforms per 100 ml over a 30-day period are posted by the medical health officers warning bathers that the waters are polluted by sewage and that they risk contracting infections to the nose and throat and acquiring gastrointestinal disorders if they bathe in

them. Bathing in sewage-contaminated water, however, is not prohibited by regulation.

Although it has been difficult to gain good epidemiological evidence that diseases could be contracted by bathing in sewage-contaminated seawater, there are sufficient data now to show that respiratory infections and gastrointestinal diseases may be transmitted through such activity (34). It is of interest to note that nearly all beaches in the Greater Vancouver Regional District now meet the guidelines for bathing waters with respect to fecal coliform count. One beach north of the Iona Island Sewage Treatment Plant, that repeatedly showed high coliform counts prior to 1988, has not exceeded 200 fecal coliforms per 100 ml since April 1988 when a deep outfall was installed for the Iona Treatment Plant. At another beach located in Deep Cove of Indian Arm, north of Vancouver, investigations are being conducted to trace the source of the chronically high fecal coliform counts which have frequently led to posting of beaches as being polluted. Contaminated runoff is suspected as the source of the high coliform concentrations.

2. Eutrophication and Red Tides

Well-flushed coastal waters seldom become over enriched with nutrients and exhibit evidence of excessive algal growth. However, semi-enclosed bodies of water which receive a large amount of nutrients from sewage and other wastes may show signs of eutrophication. An example of this on a small scale is Portage Inlet in the Victoria area, which received effluent from two small sewage treatment plants (69). It not only had unsightly growths of algae that were a nuisance to boaters and bathers, but it probably also lost its population of native oysters, *Ostrea lurida*, owing in part to this type of pollution. The problem of eutrophication is much more serious, however, in larger bodies of water such as the Seto Inland Sea of Japan (70,71). About 200 red tides occur there annually (72). One red tide in 1987 killed more than one million yellowtail fish. They occur frequently also in such heavily industrialized coastal areas as Tokyo Bay and Osaka Bay.

Red tides are known to occur naturally. In British Columbia, as in other parts of Canada and the USA, red tides may lead to paralytic shellfish poisoning (PSP). It was recorded as early as Capt. George Vancouver's voyages of exploration on the British Columbia coast in 1793, when one of his men died of PSP and several became ill after eating toxic mussels. The location where this occurred on the northern British Columbia coast was later appropriately named Poison Cove in Mussel Inlet. The PSP in British Columbia coastal waters is caused mainly by the dinoflagellates *Protogonyaulax catenella* and *P. acatenella* (formally *Gonyaulax acatenella*) (73). Shellfish are monitored regularly for PSP. Areas that have shellfish in which PSP levels exceed 80 µg per 100 g of shellfish meat are closed to harvesting by the Department of Fisheries and Oceans. Quayle (74) has described the distribution of paralytic shellfish poisoning in British Columbia and factors related to its occurrence. So far, there has been no clear-cut evidence that the dinoflagel-

late blooms, which lead to red tides and subsequently paralytic shellfish poisoning in British Columbia, have been caused by human activity.

There is growing evidence, however, that red tides have been increasing in the past decade or two along the coast of Asia and that these are related to human activity (75). Much of this increase appears to be due to enrichment with nutrients from sewage. Extensive studies on this phenomenon have been conducted in waters of Hong Kong (76,77,78,79). Much of the effort has been concentrated in Tolo Harbour (Fig. 18). The incidence of red tides has steadily increased since observations were first made in 1976. This increase in the number of red tides corresponds to the growth of human population in the catchment area and especially to the construction of two major cities on the inner shores of Tolo Harbour (Fig. 19) (76,78). The red tides are not caused by unialgal blooms of dinoflagellates. Rather, about twenty causative organisms were identified. The most dominant organisms were *Prorocentrum triestinum*, *P. dentatum*, *P. sigmoides*, *Noctiluca scintillans*, *Gymnodinium* species and a wide range of small flagellates (78).

Figure 18. Map of Hong Kong showing location of Tolo Harbour. Inset: Hong Kong in relation to southern China.

Coastal waters of Thailand have been affected by eutrophication and paralytic shellfish poison in recent years (80). The species found to bloom most frequently in the Gulf of Thailand is the blue-green alga *Trichodesmium erythraem*. On the west shores of the Upper Gulf, PSP was recorded for the first time in Thailand in 1983. The ingestion of green-lipped mussels, *Perna*

viridis, caused a small number of people to be affected by PSP in May 1983. The causative organism was identified as one of the species of *Protogonyaulax* dinoflagellates. Blooms of *Ceratium furca* and *Noctiluca* sp. were also recorded recently in the Upper Gulf of Thailand (81). Although these blooms appear to bear a relationship to increasing nutrient enrichment of coastal waters, particularly due to the disposal of untreated sewage, conclusive cause-effect linkage is still unavailable.

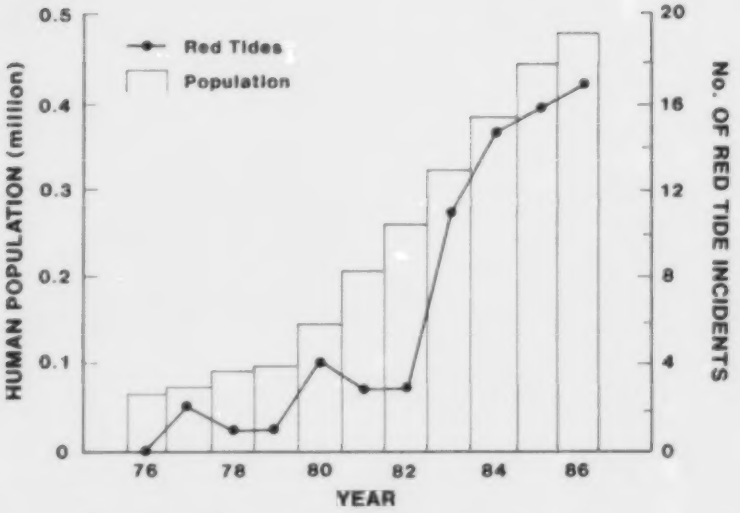

Figure 19. Increase of red tide incidents in Tolo Harbour, Hong Kong, from 1976 to 1986, and the corresponding rise in population in the catchment area. [From Lam and Ho, 1989 (79)].

There is some evidence that toxic dinoflagellates are being introduced by the discharge of ballast water and sediments from ships. Such introductions were described by the Australian delegation to the 29th Session of the Marine Environment Protection Committee (MEPC), held at the International Maritime Organization Headquarters, London, U.K., 12-16 March 1990 (82). Introduction of *Gymnodinium catenatum* in the vicinity of Hobart, Tasmania, is believed to have occurred in this way. Also the presence of *Alexandrium tamarensis* (formerly *Gonyaulax tamarensis*) in waters adjacent to Melbourne has been linked to the discharge of ballast water and sediments from ships. These dinoflagellates appear to have been carried and discharged in cyst form in the sediments. Toxic dinoflagellates are a threat to Australia's shellfish farming industry on the Tasmanian, Victoria and New South Wales coastlines. Harvesting has been closed for extensive periods, particularly on farms in Tasmania, as a precautionary measure during plankton blooms. At present,

Australia has moved to introduce national ballast water management measures designed to prevent the entry, establishment and/or spread in Australian waters of toxic and harmful marine organisms via shipping ballast water and sediment discharge. But the Australian delegation at the 29th Session of MEPC was also interested in development of international regulations to stem such introductions by ships.

DISCUSSION

In general, the state of water quality in the North Pacific would appear to be comparatively good, if one were observing on the high seas well removed from major shipping routes and away from convergence zones. However, as one moves into coastal waters, depending on the particular area, the conditions may not appear to be too pristine. There may be visual evidence of oil pollution, and the visual and olfactory senses might be offended by sewage pollution. One can generalize by stating that the effects of industrial and domestic pollution are most serious at the boundaries of the North Pacific — the land-sea boundary (shoreline), the air-sea boundary (sea surface) and the seawater-sediment boundary (sea bottom). Many of the marine living resources are concentrated at these boundaries, and the effects of pollutants can be serious there.

Most of the contamination in the North Pacific stems from the land. To some extent, the open ocean is protected from land-based sources of contamination. Only a small proportion of the terrestrial contaminants reach the open ocean via the water route (83). River-borne contaminants tend to get deposited in the sediments of the estuaries. Biogeochemical processes are active in coastal waters, and both industrial and domestic wastes discharged directly into coastal waters usually end up in the local biota and sediments. Atmospheric transport, however, does not have the same filtration and hold-up mechanisms at the land-sea boundary as present in the water route. Long-range transport by tropospheric winds adds contaminants to surface waters in the open North Pacific at great distances from their sources. The prevailing winds determine the direction of movement of air-borne contaminants, and in the North Pacific, this direction is predominantly from west to east. Air-borne contaminants from continental Asia will contaminate the waters of the western North Pacific, as shown by the distribution of mineral aerosol fluxes in Figure 1.

Deliberate and accidental discharges of wastes and other materials from ships is another mode of entry of pollutants into the marine environment, particularly on the high seas. The unfortunate aspect of ship discharges, whether it be oil or ship-generated garbage, is that much of the material floats and concentrates at the air-sea boundary. Substances like fish nets made of synthetic material, plastic bags and plastic yokes for holding beverage cans usually float and entangle birds, fish and mammmals. Although disposal of refuse from ships on the high seas has had a long tradition in the sea-faring trade, international conventions with strict regulations may have some success in reducing the deliberate discharge of wastes from ships in the marine

environment. Education is the course more likely to be successful in stemming the input of solid wastes from fishing vessels and recreational boats.

Pollution in coastal waters is best controlled by regulations imposed by national legislation. This applies to pollution by both industrial and domestic wastes. In some waste disposal activities, such as ocean dumping, national legislation has been developed to be in harmony with international conventions. Some of the international conventions, treaties and other agreements that have been brought into force to control pollution of the marine environment by various contaminants appear in Table 1. As shown earlier, international conventions, combined with national legislation, have been successful in reducing the levels of DDT, PCBs and radionuclides in the marine environment. There is evidence, although less clear-cut, that the amount of petroleum hydrocarbons in the marine environment is declining through better controls in transportation and in loading and unloading tankers under MARPOL 73/78. Because protection of human health is paramount, most nations have stringent regulations on contamination of foods. In countries, such as Canada, the U.S.A. and Japan, where eating habits allow for consumption of raw or partially cooked seafood, the bacteriological regulations are very restrictive. In other countries, where shellfish and other seafood are always well cooked, these regulations may be less stringent. Strict regulations apply in Canada and the U.S.A. to contamination by organic and inorganic chemicals. Nowhere are these more apparent than when there is contamination by dioxins and furans, particularly by the very toxic dioxin 2,3,7,8-TCDD. This was especially demonstrated when dioxins and furans were shown to be present in crustacean shellfish adjacent to coastal pulpmills in British Columbia (21). The question remains whether there are other toxic substances like dioxins and furans being inadvertently produced by industry which we have either not attempted to measure or have not had the analytical capability of measuring.

Attitudes are rapidly changing with respect to protection of the marine environment against pollution, and this applies to the North Pacific as well as globally. Some of the changing attitude has been fostered by environmental groups. Sustainable development has been proposed by the Brundtland Commission (84) as the only way that we can ensure that our resources and environment are protected for future generations. But more recently, a new outlook on the role of the oceans in buffering against increasing greenhouse gases, that are leading to climate change, has had an impact on the way we view the oceans. Anything that may damage this buffering capability must be guarded against. Toxic substances that destroy phytoplankton and other carbon-dioxide-utilizing marine plant life are just one of the potentially damaging additions to the oceans that must be avoided. Clearly, the oceans, with 97 per cent of the water on earth, are being regarded more and more as the life support system of this planet.

Table 1. International Conventions, Treaties and other Agreements to Control Marine Pollution

Convention, Treaty or Agreement	Pollution Source
International Convention for the Prevention of Pollution of the Sea by Oil, 1954	Vessels and other sources of oil
Partial Test Ban Treaty, 1963	Atmospheric nuclear weapons tests
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Dumping Convention)	Dumping at sea
International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73/78)	Ship discharges
Convention on Long Transboundary Air Pollution, 1981	Pollutants from or through the atmosphere
United Nations Convention on the Law of the Sea, 1982	Seabed activities among others
United Nations Environment Programme 1985 "Montreal Guidelines" on Protection of the Marine Environment against Pollution from Land-Based Sources	Land-based sources
World Commission on Environment and Development, 1987 (Brundtland Commission)	Any pollutants that affect sustainable development

CONCLUSIONS

1. Pollution in the north Pacific is confined mainly to the boundaries: (a) shorelines; (b) sea surface; and (c) sea bottom.
2. Coastal pollution stems largely from land-based industrial and domestic sources. The heaviest pollution generally occurs along coasts with the densest populations and industry.
3. High-seas pollution in the North Pacific is confined primarily to the sea surface and consists mostly of persistent solid wastes, such as plastic sheets, ropes and synthetic fish netting, which may entangle marine mammals, sea birds, fish and sea turtles.
4. There is evidence that the amount of petroleum hydrocarbons in the marine environment, particularly from maritime transportation, is declining. The presence of polycyclic aromatic hydrocarbons in coastal sediments, however, is a concern at present, especially in dredging and ocean disposal of dredged material.
5. Halogenated hydrocarbons are regarded as the most serious contaminants both in coastal and open-ocean waters. They reach the open ocean mostly by atmospheric transport. Declines in concentrations of such organochlorine compounds as DDT and PCBs in seawater of the North Pacific have continued since the mid-1970s, presumably owing to restrictions on use of these chemicals.
6. There has been a reduction in artificial radionuclides in seawater of the North Pacific since the Partial Test Ban Treaty of 1963. No significant increases of radionuclides in the marine environment have arisen from nuclear power reactors.
7. Inadvertent production and release of toxic dioxins and furans from the pulp and paper industry, using chlorine for bleaching, has led to recent closures of crustacean shellfisheries on the British Columbia coast. There is some concern that other toxic compounds may be unintentionally produced and released by industry and that these are not being measured at present.
8. Domestic sewage is more widespread and its economic impact is greater than that of industrial wastes in coastal waters of the North Pacific.
9. The economic effects of sewage are most felt in closures of molluscan shellfish areas for harvesting, due to high fecal coliform counts. Reduction in use of beaches by bathers because of high coliform counts has an adverse effect on amenities and recreational values of coastal waters, which means a negative impact on tourism.
10. There is growing evidence that artificial enrichment of coastal waters by nutrients from sewage, particularly along the Asiatic coast, has increased the incidence of red tides, which have affected both fish and shellfish, as well as human consumers.
11. International conventions and treaties and national legislation appear to have been effective in reducing the concentrations of undesirable con-

stituents in the marine environment such as petroleum hydrocarbons, halogenated hydrocarbons (e.g. DDT and PCBs), lead and radionuclides. It is hoped that the entry into force on 31 December 1988 of Annex V of MARPOL 73/78 will have a positive effect on the amount of litter in the North Pacific.

12. The perception of the scientific community and of the general public that the oceans serve as a buffer against the increasing input into the atmosphere of "greenhouse gases", particularly carbon dioxide, which is expected to lead to climate change, raises new concerns about introduction into the sea of toxic (or harmful for other reasons) substances which could impair that buffering capacity.

ENDNOTES

1. GESAMP, The Atmospheric Input of Trade Species to the World Ocean. IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) Reports and Studies No. 38, 1989. 111 pp. World Meteorological Organization, Geneva, Switzerland.
2. Uematsu, M.; Duce, R.A.; Prospero, J.M.; Chen, L.; Merrill, J.T.; and McDonald, R.L., Transport of mineral aerosol from Asia over the North Pacific Ocean. *J. Geophys. Res.*, 88, 1983. pp. 5343-5332.
3. Kay, B.H., Pollutants in the British Columbia marine environment — a status report. Environment Canada, Conservation and Protection, Environmental Protection, Pacific and Yukon Region, *State of the Environment Report Series*, Report No. 89-1, 1989. 59 pp.
4. Clark, R.B., *Marine Pollution*. Oxford, U.K.: Clarendon Press, 1986. 215 pp.
5. NAS, *Petroleum in the Marine Environment*. Washington, D.C.: National Academy of Sciences, 1975. 118 pp.
6. NAS, National Research Council, *Oil in the Sea: Inputs, Fates, and Effects*. Washington, D.C.: National Academy Press, 1985. 601 pp.
7. Levy, E.M., Ehrhardt, M.; Kohnke, D.; Sobtchenko, E.; Suzuoki, T.; and Tokuhiro, A., *Global Oil Pollution*. Results of MAPMOPP, the IGOSS Pilot Project on Marine Pollution (Petroleum) Monitoring. Intergovernmental Oceangraphic Commission (of Unesco), Paris, 1981. 35 pp.
8. Walder, C., *Marine transportation of oil and other hazardous substances*. International Maritime Organization, London, England, Mimeographed Manuscript, 1987. 24 pp.
9. Hodgson, B., Alaska's big spill — can the wilderness heal? *Nat. Geogr.*, 177, 1990. pp. 5-43.
10. International Maritime Organization, International Conference on Maritime Pollution, 1973 — Final Act of the Conference, with attachments, including the International Convention for the Prevention of Pollu-

tion from Ships, 1973. International Maritime Organization, London, U.K., 1977.

11. Smith, J.E. (ed.), *"Torrey Canyon" Pollution and Marine Life.* Marine Biological Association. Cambridge, U.K.: Cambridge University Press, 1968. 196 pp.
12. Sanders, H.L.; Grassle, J.F.; Hampson, G.R.; Morse, L.S.; Garner-Price, S.; and Jones, C.C., Anatomy of an oil spill: long-term effects from the grounding of the barge Florida off West Falmouth, Massachusetts. *J. Mar. Res.*, 38, 1980. pp. 265-380.
13. Day, R.H., and Shaw, D.G., Patterns in the abundance of pelagic plastic and tar in the North Pacific Ocean, 1976-1985. *Mar. Pollut. Bull.*, 18(6B), 1987. pp. 311-316.
14. Matheson, R.A.F.; Trider, G.L.; Ernst, W.R.; Hamilton, K.G.; and Hennigar, P.A., Investigation of polynuclear hydrocarbon contamination of Sydney Harbour, Nova Scotia. Environment Canada, Environment Protection Service, Atlantic Region, Dartmouth, N.S., Report EPS-5-AR-83-6, 1983. 86 pp.
15. Goyette, D., and Boyd, J., Distribution and environmental impact of selected benthic contaminants in Vancouver Harbour, British Columbia. Environment Canada, Conservation and Protection, Environmental Protection, Pacific and Yukon Region. Regional Program Report 89-02, 1989. 99 pp.
16. Bewers, J.M.; Cretney, W.; Doe, K.G.; Goyette, D.; Hennigar, P.; Keizer, P.; Levy, E.M.; Payne, J.; Tay, K.-L.; Uthe, J.F.; and Vandermeulen, J.H., Ocean Dumping under the Canadian Environmental Protection Act 1988 (Part VI) — Interim Screening and Rejection Levels for Polycyclic Aromatic Hydrocarbons (PAH). Department of Fisheries and Oceans and Environment Canada, Halifax, N.S., Mimeographed Report, 1989. 12 pp.
17. Swartz, R.C.; DeBen, W.A.; Jones, J.K.P.; Lamberson, J.O.; and Cole, F.A., Phoxocephalid amphipod bioassay for marine sediment toxicity. In R.D. Caldwell, R. Purdy and R.C. Bahner (eds.), *Aquatic Toxicity and Hazard Assessment: Seventh Symposium.* American Society for Testing and Materials, Philadelphia, PA, STP 854, 1985. pp. 284-307.
18. Goldberg, E.D., Synthetic organohalides in the sea. *Proc. Roy. Soc. Lond.*, B. 189, 1975. pp. 277-289.
19. Tatsukawa, R., Unpublished data. Changes in concentrations of organochlorine compounds in the atmosphere and surface seawater of the Pacific Ocean from 1975 to 1985. Department of Environment Conservation. Ehime University, Matsuyama, Japan.
20. Tanabe, S.; Kannan, N.; Fukushima, M.; Okamoto, T.; Wakimoto, T.; and Tatsukawa, R., Persistent organochlorines in Japanese coastal waters: An intropective summary from a Far East developed nation. *Mar. Pollut. Bull.*, 20, 1989. pp. 344-352.

21. Waldichuk, M., Dioxin pollution near pulpmills. *Mar. Pollut. Bull.*, 21, 1990. pp. 365-366.

22. Bruland, K.W., Trace elements in sea-water. In J.P. Riley and R. Chester (eds.), *Chemical Oceanography*, Vol. 8. London, U.K.: Academic Press, 1983. pp. 157-228.

23. Schaule, B., and Patterson, C.C., The occurrence of lead in the Northeast Pacific and the effects of antoropogenic inputs. In M. Branica and Z. Konrad (eds.), *Lead in the Marine Environment*. Oxford, U.K.: Pergamon Press, 1980. pp. 31-43

24. Waldichuk, M., Biological availability of metals as a factor in monitoring marine sediments for pollution. In Yu.R. Israel, A.V. Tsyban, A.S. Sarkisyan, S.P. Barinova, O.E. Geriomenkova and V.O. Mamayev (eds.), *Integrated Global Monitoring: Proceedings of the I International Symposium.* Vol. 2, pp. 30-61. Leningrad, U.S.S.R.: Gidrometeorizdat, 1986. 442 pp.

25. Waldichuk, M., Biological availability of metals to marine organisms. *Mar. Pollut. Bull.*, 16, 1985. pp. 7-11.

26. Asmund, G., Water movement traced by metals dissolved from mine tailings deposited in a fjord in N.W. Greenland. In H.J. Freeland, D.M. Farmer and C.D. Levings (eds.), *Fjord Oceanography*, pp. 347-353. New York and London: Plenum Press, 1980. 715 pp.

27. Waldichuk, M., and Buchanan, R.J., Significance of environmental changes due to mine waste disposal into Rupert Inlet. Canada Department of Fisheries and Oceans and British Columbia Ministry of Environment, West Vancouver and Victoria, British Columbia, 1980. 56 pp.

28. McGreer, E.R.; Reid, B.J.; and Vigers, G.A., Availability of metals from inorganic particulates (mine tailings) for uptake by marine invertebrates. Report prepared for Department of Fisheries and Oceans, West Vancouver, B.C., 1980. 15 pp. + Figs. & Tables.

29. Irukayama, K., The pollution of Minamata Bay and Minamata disease. *Adv. Water Poll. Res.*, 3, 1967. pp. 153-183.

30. Harbo, R.M., and Birtwell, I.K., Mercury contamination of some marine organisms from Howe Sound, British Columbia. Fisheries and Environment Canada. *Fish. Mar. Serv. Tech. Rep. No. 763*, 1978. 49 pp.

31. Peterson, C.L.; Klawe, W.L.; and Sharp, G.D., Mercury in tunas: a review. *Fish. Bull.*, 71, 1973. pp. 603-613.

32. Waldichuk, M., Some biological concerns in heavy metal pollution. In F.J. Vernberg and W.B. Vernberg (eds.), *Pollution and Physiology of Marine Organisms*, pp. 1-57. New York, N.Y.: Academic Press, 1974. 492 pp.

33. Thain, J.E., and Waldock, M.J., The impact of tributyl tin (TBT) antifouling paints on molluscan fisheries. *Wat. Sci. Tech.*, 18, 1986. pp. 193-202.

34. Davies, I.M., and McKie, J.C., Accumulation of total tin and tributyl tin in muscle tissue of farmed Atlantic salmon. *Mar. Pollut. Bull.*, 18, 1987. pp. 405-407.

35. GESAMP, *The State of the Marine Environment.* IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) Reports and Studies No. 39, 1990. 11 pp. United Nations Environment Programme, Nairobi, Kenya.

36. Trefry, J.H.; Metz, S.; Trocine, R.P.; and Nelson, T.A., A decline in lead transport by the Mississipi River. *Science* 230, 1985. pp. 439-441.

37. Patterson, C.C., and Settle, D.M., Review of data on eolian fluxes of natural lead to lands and seas in remote regions on a global scale. *Mar. Chem.*, 22, 1987. pp. 137-162.

38. NAS, National Research Council, *Radioactivity in the Marine Environment.* Panel on Radioactivity in the Marine Environment of the Committee on Oceanography. National Academy of Sciences, Washington, D.C., 1971. 272 pp.

39. Miyake, Y.; Saruhashi, K.; Sugimura, Y.; Katsuragi, Y.; and Kanazawa, T., Nuclear weapons and radioactive pollution of the earth's environment. In Y. Miyake *et al.* (eds.), *Damage and After-Effects of the Atomic Bombing of Hiroshima and Nagasaki.* Tokyo, Japan: Asahi Evening News Co., 1978. pp. 164-188.

40. Jacquish, R.E., and Mitchell, P.J. (eds.), *Environmental Monitoring at Hanford for 1987.* Battelle Pacific Northwest Laboratory, Richland, Washington. Prepared for the U.S. Department of Energy. Report PNL-6464, 1988. 97 pp. + Appendices A-G.

41. NAS, *Disposal of Low-Level Radioactive Waste into Pacific Coastal Waters.* A Report of a Working Group of the Committee on Oceanography. National Research Council Publication No. 985. Washington, D.C.: National Academy of Sciences, 1962. 87 pp.

42. Cundell, A.M., Plastics in the marine environment. *Environ. Conserv.*, 1, 1974. pp. 63-68.

43. Merrell, T.R., Jr., Accumulation of plastic litter on beaches of Amchitka Island, Alaska. *Mar. Environ. Res.*, 3, 1980. pp. 171-184.

44. Norway, *Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft of 1972.* Signed at Oslo, Norway, 15 February 1972, pp. 505-511.

45. United Kingdom, *Final Act of the Inter-Governmental Conference on the Convention on the Dumping of Wastes at Sea* (with Convention, Technical Memorandum and Resolution) London, 13 November 1972. Cmnd. 5169. Her Majesty's Stationery Office, London, England.

46. Waldichuk, M., Plastics and seals. *Mar. Pollut. Bull.*, 9, 1978. p. 197.

47. Sanger, G.A., On the effect of fish net scraps and other oceanic debris on northern fur seals. Background Paper, Seventeenth Meeting, Standing Scientific Committee, North Pacific Fur Seal Commission, 11 March

1974. Headquarters of the North Pacific Fur Seal Commission, Washington, D.C.

48. Fowler, C.W., The evaluation of the role of entanglement in the population dynamics of northern fur seals on the Pribilof Islands. In R.S. Shomura and H.O. Yoshida (ed.), *Proceedings of the Workshop on the Fate and Impact of Marine Debris*, 26-29 November 1984, Honolulu, Hawaii. US Dept. Commer., NOAA Tech, Memo. NOAA-TM-NMFS-SWFC-54, 1985. pp. 291-307.
49. Fowler, C.W., Marine debris and northern fur seals: a case study. *Mar. Pollut. Bull.*, 18(6B), 1987. pp. 326-335.
50. Ribic, C.A., and Bledsoe, L.L., Design of surveys for density of surface marine debris in the North Pacific. Final Report. NWAFC Processed Report 86-12, 1986, 69 pp. Northwest and Alaska Fisheries Center, Natl. Mar. Fish. Serv., Natl. Oc. Atmos. Admin., Seattle, Wash.
51. Day, R.H.; Clausen, D.M.; and Ingell, S.E., Distribution and density of plastic particulates in the North Pacific Ocean in 1986. Document submitted to the International North Pacific Fisheries Commission, Anchorage, Alaska, November 1986, 17 pp.
52. Berger, J.D., and Armistead, C.E., Discarded net material in Alaskan waters, 1982-84. US Dept. Commer., NOAA Tech. Memo. NMFS/F/NWC-110, 1987. 66 pp.
53. Merrell, T.R., and Johnson, S.W., Surveys of plastic litter on Alaskan beaches, 1985. US Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-116, 1987. 21 pp.
54. Day, R.H., and Shaw, D.G., Patterns in the abundance of pelagic plastic and tar in the North Pacific Ocean, 1976-1985. *Mar. Pollut. Bull.*, 18(6B), 1987. pp. 311-316.
55. Johnson, S.W., and Merrell, T.R., Entanglement debris on Alaskan beaches, 1986. US Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-126, 1988. 26 pp.
56. Connor, D.K., and O'Dell, R., The tightening net of marine plastics pollution. *Environ.*, 30, 1988. pp. 17-36.
57. Strickland, D., Cleaning up the debris mess. *Pacific Fishing*, 9, 1988. pp. 43-49.
58. Mio, S., Sighting surveys on marine debris (Abstract). *Proceedings North Pacific Rim Fishermen's Conference*, Kailua-Kona, Hawaii, 13-16 October 1987.
59. Mio, S., and Takehama, S., Estimation of distribution of marine debris based on the 1986 sighting survey. Document submitted to the Annual Meeting of the International North Pacific Fisheries Commission, Vancouver, Canada, October 1987, 16 pp.
60. Henderson, J.R., Encounters of Hawaiian monk seals with fishing gear at Lisianski Island, 1982. *Mar. Fish. Rev.*, 46, 1984. pp. 59-61.

61. Henderson, J.R., A review of Hawaiian monk seal entanglements in marine debris. In R.S. Shomura and H.O. Yoshida, (eds.), *Proceedings of the Workshop on the Fate and impact of Marine Debris*, 27-29 November 1984, Honolulu, Hawaii, US Dept. Commer., NOAA Tech. Memo NMFS, NOAA-TM-NMFS-SWFC-54, 1985. pp. 326-335.

62. Henderson, J.R., Marine debris in Hawaii. In D.L. Alverson (ed.), *Proceedings of the North Pacific Rim Fishermen's Conference on Marine Debris*, 13-16 October 1987, Kailua-Kona, Hawaii. Seattle, Washington: Natural Resources Consultants, in press.

63. Balazs, G.H. Impact of ocean debris on marine turtles: entanglement and ingestion. In R.S. Shomura and H.O. Yoshida, (eds.), *Proceedings of the Workshop on the Impact and Fate of Marine Debris*, 27-29 November 1984, Honolulu, Hawaii. US Dept. Commer., NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFC-54, 1985. pp. 387-429.

64. NAS, *Assessing Potential Ocean Pollutants*. Washington, D.C.: National Academy of Sciences, 1975. 438 pp.

65. IMO, Plastics dumping to be banned with Annex V's entry into force. *IMO News*, No. 1, 1988, p. 1. International Maritime Organization, London, U.K.

66. Waldichuk, M., The nature and extent of marine contamination caused by land-based sources in Canada. In P.G. Wells and J. Gratwick, (eds.), *Canadian Conference on Marine Environmental Quality: Proceedings*, 29 February-3 March 1988, Halifax, Nova Scotia, pp. 75-135. International Institute for Transportation and Ocean Policy Studies, Halifax, N.S., 1988. 320 pp.

67. National Shellfish Sanitation Program, *Manual of Operations, Part I. Sanitation of Shellfish Growing Areas*. 1989 Revision. US Dept. of Health and Human Services, Public Health Service, Washington, D.C.

68. Kay, B.H., Unpublished data. Trends in B.C. shellfish closures 1972-1989. Environment Canada, Conservation and Protection, Environmental Protection, West Vancouver, B.C.

69. Health and Welfare Canada, Guidelines for Canadian Recreational Water Quality. Prepared by the Federal-Provincial Working Group on Environmental and Occupational Health, 1983.

70. Waldichuk, M., Eutrophication studies in a shallow inlet on Vancouver Island. *J. Wat. Pollut. Contr. Fed.*, 41, 1969. pp. 745-764.

71. Tokyo University of Fisheries, An assessment of the effects of pollution on fisheries and aquaculture in Japan. Food and Agriculture Organization of the United Nations, FAO Fish. Tech. Paper No. 163, 1976. 105 pp.

72. Yanagi, T., Preserving the Inland Sea. *Mar. Pollut. Bull.*, 19, 1988. pp. 51-53.

73. Murakawa, M., Marine pollution and countermeasures in Japan. *Oceanus*, 30, 1987. pp. 55-60.

74. Prakash, A., and Taylor, F.J.R., A "red water" bloom of *Gonyaulax acatenella* in the Strait of Georgia and its relation to paralytic shellfish toxicity. *J. Fish. Res. Bd. Can.*, 23, 1966. pp. 1265-1270.

75. Quayle, D.B., Paralytic shellfish poisoning in British Columbia. *Bull. Fish. Res. Bd. Can.*, 168, 1969. 68 pp.

76. Waldichuk, M., Marine biotoxins and human activity. *Mar. Pollut. Bull.*, 21, 1990. pp. 215-216.

77. Holmes, P.R., and Lam, C.W.Y., Red tides in Hong Kong waters — response to a growing problem. *Asian Mar. Biol.*, 2, 1985. pp. 1-10.

78. Chan, B.S.S., and Hodgkiss, I.J., Phytoplankton productivity in Tolo Harbour. *Asian Mar. Biol.*, 4, 1987. pp. 79-90.

79. Lam, C.W.Y., and Ho, K.C., Red tides in Tolo Harbour, Hong Kong. In T. Okaichi, D.M. Anderson and T. Nemoto, (eds.), *Proceedings of the First International Symposium on Red Tides*, November 10-14, 1987, Takamatsu, Kagawa Prefecture, Japan. Amsterdam: Elsevier Science Publishing Co., Inc., 1989. pp. 49-52.

80. Morton, B., Pollution of the coastal waters of Hong Kong. *Mar. Pollut. Bull.*, 20, 1989. pp. 310-318.

81. Hungspreugs, M.; Utoomprurkporn, W.; Dharmvanij, S.; and Sompongchaiyakul, P., The present status of the aquatic environment of Thailand. *Mar. Pollut. Bull.*, 20, 1989. pp. 327-332.

82. Tamiyavanish, S., The causes and impacts of the red tide phenomenon occurring in the Upper Gulf of Thailand. In *Proceedings of the Third Seminar on the Water Quality and Quality of Living Resources in Thai Waters*. 26-28 March 1984. pp. 481-486. National Research Council of Thailand, Bangkok.

83. IMO, Controls on discharge of ballast water. Paper submitted by Australia to the 29th Session of the Marine Environment Protection Committee, International Maritime Organization, London, U.K., MEPC 29/21/2, 1990. 13 pp.

84. GESAMP, *Land-Sea Boundary Flux of Contaminants: Contributions from Rivers*. IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) Reports and Studies No. 32, 172 pp. UNESCO, Paris, 1987.

85. World Commission on Environment and Development, *Our Common Future*. Oxford, U.K.: Oxford Univesity Press, 1987. 400 pp.

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Possible Impacts of Climate Change on the North Pacific Ocean and its Marine Resources†

INTRODUCTION

The marine resources of the North Pacific Ocean are linked to the past and present climates of the region. Each part of the ecosystem adjusts in response to climatic forcing, depending on its sensitivity and response time, and the climate, in turn, adjusts to the impacts of the changing ecosystem. Although climate has always been changing, now, for the first time, the effects of human activities are having an important impact and may be dominant over the next century or more. In this paper, the possible changes in the climate of the North Pacific Ocean will be described and put in the context of variability over the recent past. Possible impacts of climate change will be identified.

Climate Variability

There is a wide range of time and space scales of climate variability. Atmospheric motions cover the scales from hours and kilometres (mesoscale showers and topographic winds, for example) through to global scale weather systems with spatial scales of 10,000 or more kilometres (Fig. 1). Even these largest scale atmospheric motions have time scales of only a month or so. We also know that the atmosphere rains out its water content in about 10 days and the radiative adjustment time is about a month. Hence, in a relative sense, the atmosphere adjusts very rapidly and has little long-term memory, except through its chemical composition. Many trace gases, such as chlorofluorocarbons, have atmospheric lifetimes of about a century. Other important parts of the climate system are groundwater, snow and sea ice. Our best estimates of their adjustment times are a few months for soil moisture and about a

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year for snow and sea ice. This means that information on the atmosphere alone (except for its composition) provides very limited predictive skill; information on the distribution of soil moisture may help us predict ahead a season, while the distribution of sea ice boundaries may allow us to extend our vision into the next year.

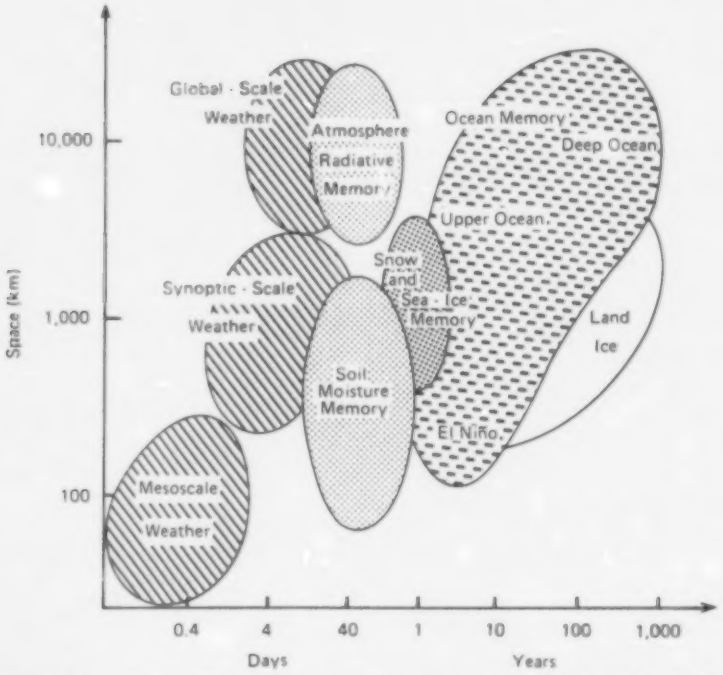

Figure 1. Schematic representation of the time and space scales of parts of the climate system.

The oceans are the part of the climate system with the longest memory. Oceans in general, and the Pacific Ocean in particular, can be divided into an upper layer of 100-150 m depth, that responds directly to atmospheric forcing and a lower layer beyond local atmospheric influence (Fig. 2) (Tabata 1965; LeBlond and Thomson 1990). The upper layer warms and cools with the seasonal cycle, although somewhat lagged, and has relatively uniform properties with depth. It is frequently referred to as the mixed layer, the mixing arising due to wind-induced turbulence and density changes at the ocean surface. The surface density may be increased either through loss of heat or increase in salt content. The latter can be achieved by evaporation exceeding precipitation or by sea ice forming. The response time of the upper ocean is up to several years,

while the response time of the deep ocean can extend beyond 1000 years. Residence times for major ice sheets (Antarctica and Greenland) are hundreds to thousands of years.

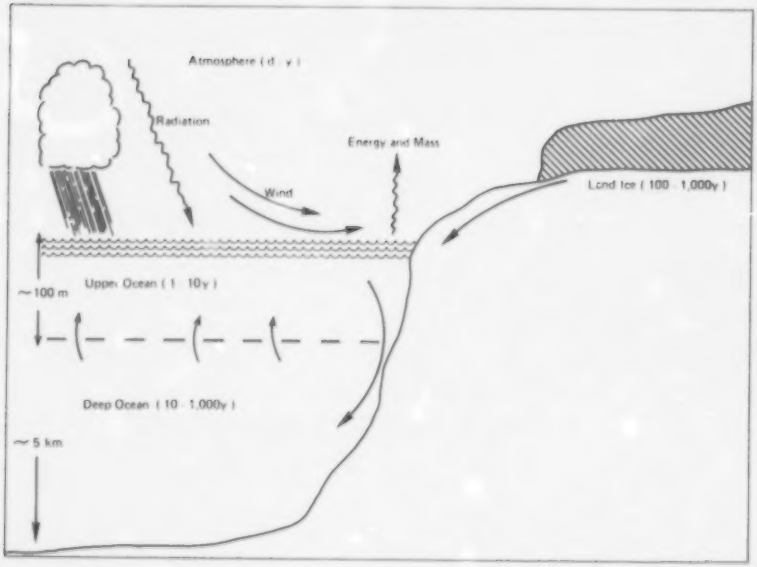

Figure 2. Illustration of the interactions between the atmosphere and the oceans and the time scales of each component.

We are primarily interested in the possibility of climate change over the next one-to-two hundred years. For this period, the oceans provide the dominating factor for longer-term adjustment of the climate system. It is useful to think of the climate system as being divided into two components: the fast and slow climate systems. The fast climate system is the atmosphere, the upper ocean (that part subject to an annual cycle of vertical mixing due to wind) and the transient processes at land surfaces. The fast climate system is active, driven by the atmospheric engine, and comes to statistical equilibrium in a few years. The slow climate system consists mainly of the deeper ocean and the perennial land ice, with a response time of decades to centuries. The major interactions between the fast and slow climate systems take place in a limited number of areas where heat is transferred by the up- or downwelling of ocean water and at high latitudes where cold, dense water sinks to great depths (Fig. 2). To a first approximation, the magnitude of climate response to external forcing, such as increasing greenhouse gas concentrations or changes

in solar irradiance at the top of the atmosphere, will be determined by the fast climate system; the decadal rate of change will be determined by the slow climate system.

The climate system exhibits a large amount of natural variability, that seems to be driven by non-linear interactions between its various components. The largest contributor to interannual variability of the climate system is the *El Niño* — South Oscillation (ENSO) of the tropical Pacific Ocean. It is now clear that ENSO events, occurring with an average frequency of 4-5 years, have global significance. Mysak (1986) has reviewed the evidence for direct connections between variations in the tropical Pacific and at higher latitude, and their relationship to the fishery. The general interannual variability of the Gulf of Alaska and the Eastern Bering Sea was the topic of a workshop (Wooster 1983).

GLOBAL CLIMATE CHANGE DUE TO INCREASING ATMOSPHERIC CONCENTRATIONS OF GREENHOUSE GASES

The earth's climate is a highly nonlinear system with a multitude of interacting components and its response to a perturbation is not always clear. It is known that the earth's climate is greatly influenced by the presence of water and carbon dioxide in the atmosphere. Water vapour and carbon dioxide are two strong "greenhouse" gases. They absorb earth's outgoing radiation and re-emit radiation both up and down. The result is that little of the radiation from the earth's surface directly passes out to space. Instead, there is transfer of radiation outward, from layer to layer, until the actual emission to space is primarily from molecules that are much colder than the earth's surface. Since the intensity of emitted radiation is very temperature dependent, this process acts, in a sense, like a "greenhouse". The gases retain extra heat in the atmosphere and result in a warmer climate than there would otherwise be. When viewed from space, the earth has an effective radiative temperature of about -18°C, while the average surface temperature of our planet is 15°C. This is a natural greenhouse of + 33°C; without it, life on earth would not be possible. Water in another form, as clouds, also has a large impact on climate. Low clouds generally cool the planet by reflecting more solar radiation back to space, although they also trap radiation below them. High clouds generally warm the planet since high cirrus clouds reflect little solar radiation while trapping earth's radiation. Although the balance is very delicate, our best measurements from space now indicate that the present distribution of cloudiness cools our planet (Ramanathan et al. 1989). Although the amounts of atmospheric water vapour or cloudiness are not changing significantly at present, the atmospheric concentration of carbon dioxide is increasing. Measurements of CO_2 concentration in air trapped in glacier ice show that the pre-industrial concentration was about 280 ppm; present measurements show its value near 350 ppm, an increase of 25 per cent.

The recent Intergovernmental Panel on Climate Change, Working Group I, Scientific Assessment Report (IPCC 1990; hereafter IPCC I) has reviewed the

scientific background, past and projected emissions of greenhouse gases and assessed their impact on climate. Presently, anthropogenic activities result in emissions to the atmosphere of about 5-7 gigatons of carbon (GtC; 1-Gt = 10^{12}kg) (Fig. 3). These anthropogenic emissions are against natural transfers totalling about 200 GtC. However, natural exchanges must be nearly in equilibrium; otherwise, atmospheric carbon dioxide concentrations would be changing more rapidly. Recent data indicate that the atmospheric CO_2 concentration is increasing about 3 GtC per year, so that approximately 50 per cent of the carbon emissions remain in the atmosphere and the other half is absorbed by either the oceans (probably most) or the terrestrial ecosystem. Future atmospheric concentrations of CO_2 will depend on global energy, land-use and other policies. IPCC I considered four emission scenarios (which can be very approximately described as: BAU = business as usual; B = low emissions scenario; C = control policies scenario; D = accelerated control policies scenario) which were used for illustrative purposes. Figure 4 shows the emissions and computed atmospheric CO_2 concentrations for the next 120 years, based on these emission scenarios. Similar emission scenarios were developed for methane, chloroflourocarbons (CFC) and nitrous dioxide, the other main greenhouse gases.

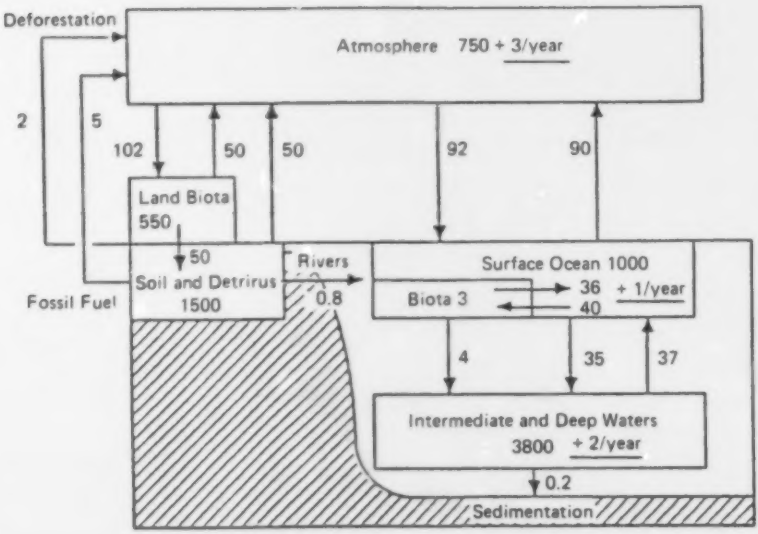

Figure 3. Global carbon reservoirs and fluxes. Fluxes (shown by arrows) are gross annual exchanges. Underlined numbers indicate the net annual $C0_2$ accumulation due to human activities. Units are GtC (gigatons of carbon) for reservoir sizes and GtC y^{-1} for fluxes. Reproduced from IPCC I. Based on various literature values.

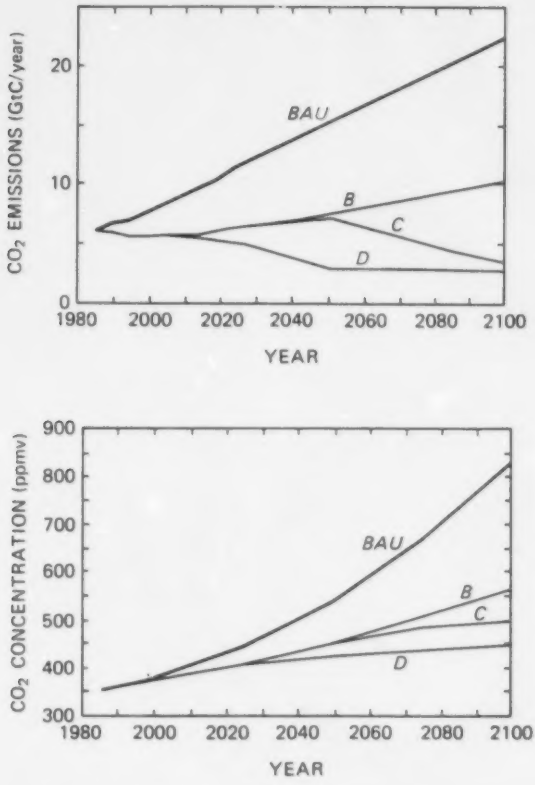

Figure 4. (a) $C0_2$ emissions in GtC y^{-1} for four future scenarios of human activities. From IPCC I. (b) Computed atmospheric concentrations of $C0_2$ (in ppmv. parts per million by volume). From IPCC I.

Atmospheric scientists can compute, for a given concentration and distribution of atmospheric radiatively active gases, the increased radiative forcing on the lower atmosphere. For example, doubling the CO_2 concentration (or the radiative equivalent in other greenhouse gases) increases the radiative forcing on the lower atmosphere by about 4 Wm^{-2}. This is a small change compared to the typical fluxes of 50-100 Wm^{-2} in the atmosphere or the average solar irradiance at the top of the atmosphere (342 Wm^{-2}). In fact, 4 Wm^{-2} is much smaller than our present accuracy of measurements (10-20 Wm^{-2}). Effectively, the climate system absorbs 4 Wm^{-2} additional energy and warms up in order to increase outgoing radiation and re-establish radiative equilibrium. If no feedback or other complicating processes were involved, this additional radiative forcing would warm the global mean surface temperature by 1.2°C. However, there are important feedback processes that change the climate system's response.

The most appropriate way to understand the climate system response is through the construction and use of very sophisticated global models. As yet, most global climate models have inadequate treatment of the oceans and processes of the water cycle, particularly clouds and radiation, precipitation and land-surface hydrology. The biosphere is not included in any interactive way. Existing ocean climate models have very coarse resolution with highly simplified representations of mixing and other processes. The approach adopted by most global climate modellers has been to represent the oceans as mixed layers of 50 m depth that exchange heat and mass with the atmosphere but have no currents and no interaction with the deep ocean. A full model of the ocean, with sufficient horizontal and vertical resolution to resolve the oceanic eddies, would exceed the capacity of today's supercomputers and, further, oceanographers are not yet agreed upon the optimum method of modelling parts of the oceans' structure. In essence, most present global climate models are models of the fast climate system. Thus, they can simulate an equilibrium climate with steady doubled atmospheric concentration of greenhouse gases, but cannot simulate the evolution of the climate as a time-dependent response to varying greenhouse gas concentrations.

The IPCC I Report summarized the results of many global climate models for equilibrium climate change corresponding to doubled atmospheric concentration of greenhouse gases (Table 1). Two main points are: high sensitivity of the UKMO model (and probably all models) to changes in cloud-radiative properties; and the consistency of the high resolution models in predicting δT of 3.5-4.0°C. Clearly much further research needs to be done to understand and model cloud-radiative properties for use in climate models. It was also noted that differences between models seem to be becoming smaller as resolution increased. A high resolution model in this context has about 3 degrees of latitude-longitude resolution. It was the scientific opinion of IPCC I that, as the parameterizations of cloud-radiation feedback processes improved, the sensitivity of climate models to increasing CO_2 concentrations would decrease. The IPCC I then concluded that the equilibrium global mean temperature would change between 1.5 and 4.5°C, with a "best estimate" of 2.5°C. The IPCC I also concluded that the high northern latitudes will warm by about twice the global mean, the tropical latitudes will warm less than the global mean and the land areas will warm more than the oceanic areas. Changes at high southern latitudes are less clear but are likely to be small. The IPCC I Report, however, added a caution: surprises in the climate system are possible and unknown biospheric and other feedbacks could cause more rapid and/or larger climate change.

The models also predict that global precipitation will increase (by 3 to 15%) (Table 1) (evaporation will increase by the same amount), but models differ widely in their prediction of regional variations. Although the theoretical maximum intensity of tropical storms will increase (Emmanuel 1987), models give no consistent indication as to the change in frequency or intensity of tropical storms. Because high northern latitudes are expected to warm more than the tropical regions, the average equator to north pole temperature

gradient will decrease. Since this is a main driving force for mid-latitude storms, storms might be expected to decrease in intensity or frequency. However, water content of the atmosphere will increase providing more potential for diabatic heating, another source of energy for these storms. Climate models do give some indication of a reduction in day-to-day variability in mid-latitude storm tracks in winter. Higher-resolution models are needed before the issue can be clarified.

Table 1. Examples of modelled changes in global mean climate corresponding to double atmospheric concentration of atmospheric CO_2. Each model consists of a comprehensive atmospheric model coupled to a mixed layer ocean model.

Model	δT(°C)	δP(%)	Comments
GFDL	4.0	8	Geophysical Fluid Dynamics Lab
	4.0	8	similar to above, but higher resolution
UKMO	5.2	15	U.K. Meteorological Office
	2.7	6	changed cloud water scheme
	1.9	3	variable cloud radiative properties
	3.5	9	higher resolution
CCC	3.5	4	Canadian Climate Centre, high resolution

As noted, models used to compute equilibrium climate change do not include a full ocean. Importance of the ocean becomes particularly critical for the determination of the transient response to time-varying concentrations of greenhouse gases. First, the actual concentration of greenhouse gases depends on the ocean. As noted above, about half of the carbon dioxide emitted through human activities remains in the atmosphere and it is assumed that most of the remaining is absorbed by the oceans (Fig. 3). Since carbon dioxide is absorbed into cold water and outgassed from warm water, the absorption takes place primarily at high latitudes of the North Atlantic and around Antarctica where deep convention transports carbon dioxide rich surface water to depth. There is also a "biological pump" which transports carbon into the deep ocean.

The second major role of oceans is to uptake heat and, because of their great heat capacity, to slow any climate change. The upper layers of the ocean can absorb considerable heat for a small temperature change. The transfer of heat from the surface layer to below the thermocline, for most of the ocean, must take place by relatively inefficient diffusion processes. On the other hand, deep convection leads to very efficient transfer of heat to the deep ocean. However, this process only works at high latitudes where the density is

determined mostly by salinity, not by temperature. Hence, a parcel of water warm relative to the deep water can still sink and diffuse its heat to other parcels at depth. The sinking of water at high latitudes and slow upwelling at lower latitudes, and the horizontal transports connecting them, is referred to as the thermohaline circulation. The role of the ocean in affecting the rate of climate change can come in two ways (Fig. 5). First is as a lag or delaying factor. For a given fast climate system response, the response of the total climate system (fast plus slow) will be similar to a capacitance circuit. Initially, the rate of change will be very small; however, after a lag of time (L), the rate of change of the whole system will be the same as that for the fast component.

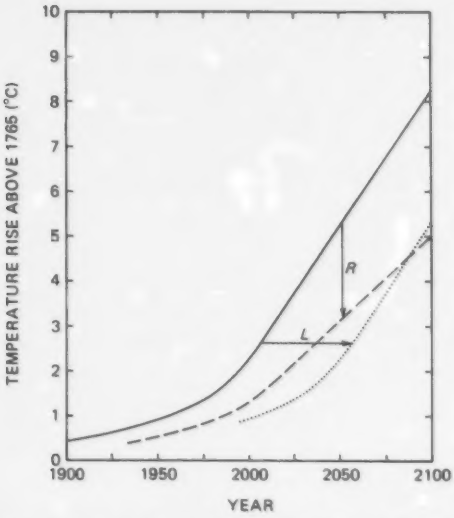

Figure 5. Schematic of role of ocean in modifying global climate change. Shown are: response of fast climate system to BAU emission scenario, assuming $\delta T = 4°C$, for equilibrium doubled-CO_2 (solid curve); response of coupled climate system if the ocean reduces the rate of climate change by a factor (R) (long dashed curve); response of coupled climate system if ocean primarily delays climate change by a lag (L) (short dashed curve).

This type of system would be expected if the ocean was only absorbing heat relatively uniformly over its surface and slowly diffusing the heat in the next century, assuming a lag of a few-to-several decades. On the other hand, if deep convection is the dominant process, heat is being removed from the upper ocean and "stored" at depth, where the adjustment time is several hundred years or more (this is essentially infinite as far as predicting the response for the next century). Since deep convection is removing heat from the active climate system, it effectively reduces the rate of climate change, perhaps by some fraction (R).

Stouffer *et al* (1989) completed simulations with an atmospheric climate model coupled to a 12-layer, coarse-resolution ocean model that included a thermohaline circulation. A control case with constant carbon dioxide concentration was compared to one with greenhouse gas concentrations increasing at 1% per year. The global mean temperature difference between the two cases increased approximately linearly, after an initial period, to 2.3°C after 70 years (the time when the CO_2 concentration was double the initial state). By comparison, the same atmospheric model coupled to a mixed-layer ocean model warmed by 4.0°C (see Table 1, GFDL), when in equilibrium with doubled CO_2. The ratio of temperature changes, as deviations from the fixed CO_2 control case, for the two different ocean models, was 0.6 globally and varied regionally between 0.6 and 0.8, except for the North Atlantic around 60°N, where the ratio dropped to less than 0.4, and for the Antarctic Circumpolar Current, where ratio was less than 0.2. An obvious interpretation of this ratio is as a measure of the importance of deep convection; the lower the number, the greater the importance of deep convection, and vice versa. For the global mean, the Stouffer *et al.* (1989) model results imply that the dominant effect of the oceans is to reduce the rate of change of climate ($R \sim 0.6$) with a small lag ($L \sim 10$ y). However, these results are very preliminary and no conclusions can yet be drawn.

As the climate warms in the Stouffer *et al.* model, increasing precipitation over the North Atlantic freshens the surface waters, reduces their density, and decreases deep convection. Eventually, if the deep convection stops, the cause of the reduced warming over the North Atlantic will disappear, leading to the possibility that climate warming may accelerate. Since deep convection is also responsible for removal of carbon dioxide from the surface waters, reduction of deep convection would reduce the rate of uptake of CO_2 by the ocean and allow the rate of increase in the atmosphere (for the same rate of emissions) to accelerate. Through these processes, the ocean may provide a strong positive feedback on greenhouse gas warming of the climate. There is some evidence that changes of this type may have occurred naturally in the past (Broecker 1987; Broecker *et al.* 1985).

Any prediction of actual climate change depends on the rate of increase of atmospheric concentration of greenhouse gases which depends on the emissions from human activities as well as natural processes. The IPCC "business as usual" emissions scenario resulted in predictions of about 0.3°C per decade (with an uncertainty range of 0.2°C to 0.5°C per decade) increase in global mean temperature. This corresponds to an increase of about 1°C, above present values, by 2025 and 3°C by 2100 (Fig. 6).

Associated with climate change will be other changes to the earth system, including the level of the seas. Relative mean sea level rise may rise due to changes in water volume (through additions from land glaciers or by thermal expansion), in water surface shape, coastal subsidence and/or large-scale crustal and subcrustal movements. Change in relative mean sea level is still a controversial topic (Stewart *et al.* 1990). Thomson and Tabata (1989) have found that steric heights in the Northeast Pacific have been increasing at a rate

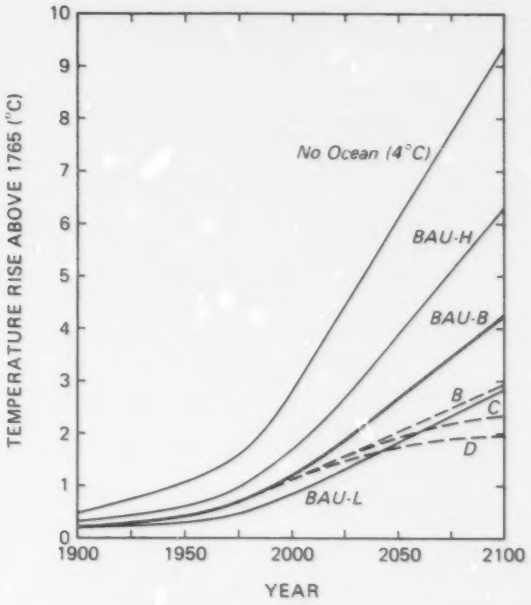

Figure 6. Computed temperature rise, above values in 1765 (°C), for no-ocean (fast climate system) and for the coupled climate system for the Business-as-usual emissions scenario, for IPCC I. BAU-H is the high estimate, BAU-L is the low estimate, and BAU-B is the "best estimate".

of about 1 mm y^{-1} which is similar to the value found by Barnett (1984) through the analysis of coastal tide gauge records. For the predicted temperature increases noted above, a simple diffusion model of the oceans implies an average rate of increase of global mean relative sea level of about 6 cm per decade (uncertainty range 3 to 10 cm per decade), mainly due to thermal expansion of the oceans and the melting of some land ice. This amounts to a rise of about 20 cm by 2030 and 65 cm by 2100 (Fig. 7). If the emission rates are decreased, temperature and sea level rates of change will also decrease. It should be expected that the actual rates of change will not be steady and will vary regionally (IPCC I).

CLIMATE CHANGE OF THE NORTH PACIFIC

The waters of the North Pacific Ocean are the least saline and among the oldest of the major ocean basins (LeBlond and Thomson 1990; Tabata 1975, 1976). The Pacific Ocean is more stably stratified than the Atlantic Ocean. Due to the stratification of the North Pacific, its evolution is slow, with general northward motion of deep waters, slow upward diffusion of properties and return southward of near-surface water. Because the North Pacific Ocean has very little

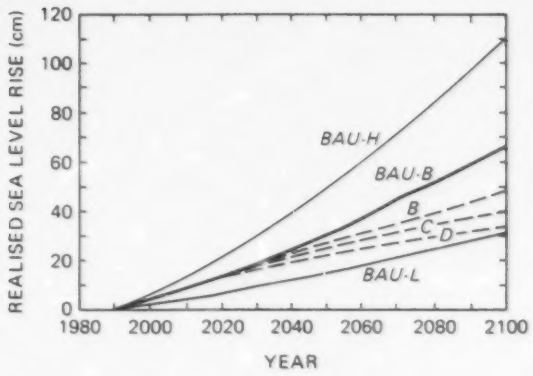

Figure 7. Realized sea level (cm) for the BAU emissions scenario: high, low and best estimates. From IPCC I.

deep convection, it plays a much less role in the removal of heat from the surface layers of the ocean. As described in LeBlond and Thomson (1990), there is formation of intermediate waters by sinking of waters in the northwest Pacific to 600 m. Its role for carbon dioxide is also likely less, but little data is available.

Given the above information on the changes of the global climate with increasing greenhouse gas concentrations, what changes might be expected for the North Pacific Ocean and adjoining land regions? It must be stressed that the uncertainty in regional predictions is much larger than for global mean predictions. However, for the North Pacific, the temperature changes are reasonably consistent among the high-resolution climate models (Table 1). In Figure 8, the results from the Canadian Climate Centre climate model are presented (Boer *et al.* 1991). The CCC model is recognized as one of the best in the world (IPCC I). In the winter, the northwest Pacific (north of 40°N) would warm by about 2.5°C while the eastern half of the Ocean would warm less, but more than about 1.5°C. The summertime warming values over the North Pacific are similar to the winter values, however the Bering Sea summertime warming values (see below) are similar to the rest of the North Pacific.

Warming in the Bering Sea in winter ranges from 4°C (UKMO) to 8°C (CCC and GFDL). The large warming is similar to that predicted for the whole Arctic region. There are several reasons for this poleward enhancement of the warming. Reduction of sea ice over the Arctic, mainly in the summer (the CCC and UKMO models predict a summertime ice-free Arctic Ocean) leads to more solar heat absorption. Thinner ice in winter allows more heat to escape through in winter and warming is confined to a shallow surface layer of the atmosphere. There are also positive feedback effects due to enhanced water vapour content and earlier melting of ice. It would be expected that the ice edge would retreat in the Bering Sea in the winter, relative to the present position. Because of the

coarse resolution of the models and poor treatment of the oceans, positions of ice edges are not too reliable.

Regional variations in precipitation are much more difficult to predict and models show considerable local variation. In winter, the CCC model shows an increase of up to 2 mm/day over the northeast Pacific, near 50°N, but decreases over the northwest Pacific. Since the precipitation over this region of the Pacific is also about 2 mm/day (Elliott and Reed 1984), this corresponds to a very large percentage increase. The GFDL and UKMO models both show general increases over most of the Pacific north of 30°N, but smaller decreases southward. In summer, changes are smaller.

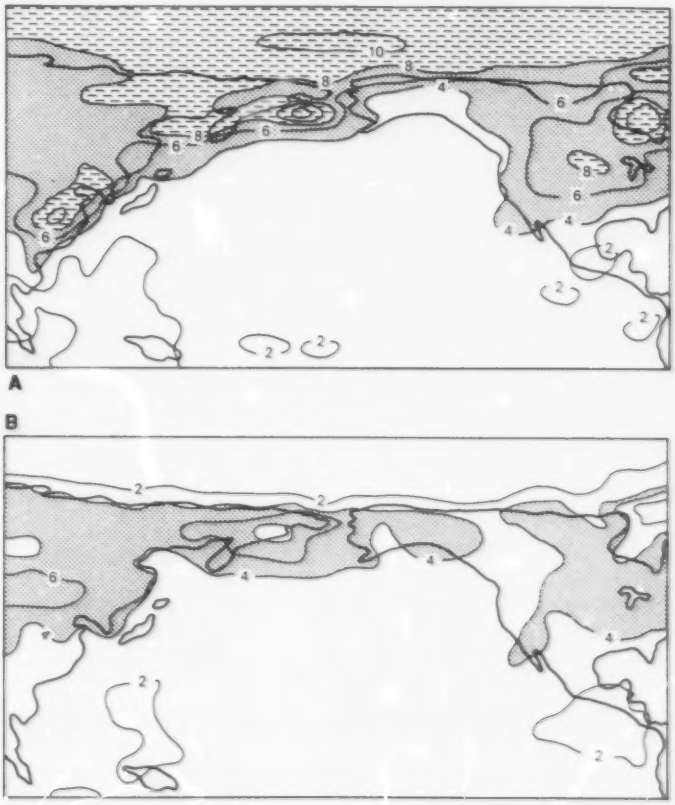

Figure 8. North Pacific region equilibrium climate change for doubled-CO_2 atmospheric concentration, as simulated by the Canadian Climate Centre climate model (Boer *et al.* 1991). (a) δT for wintertime (December, January, February), in °C; (b) δT for summertime (June, July, August), in °C; (c) δP for wintertime (December, January, February), contours are ±0,1,2,5 mm d^{-1} (mm precipitation per day), areas of decrease stippled; d) δP for summertime (June, July, August), contouring as (c).

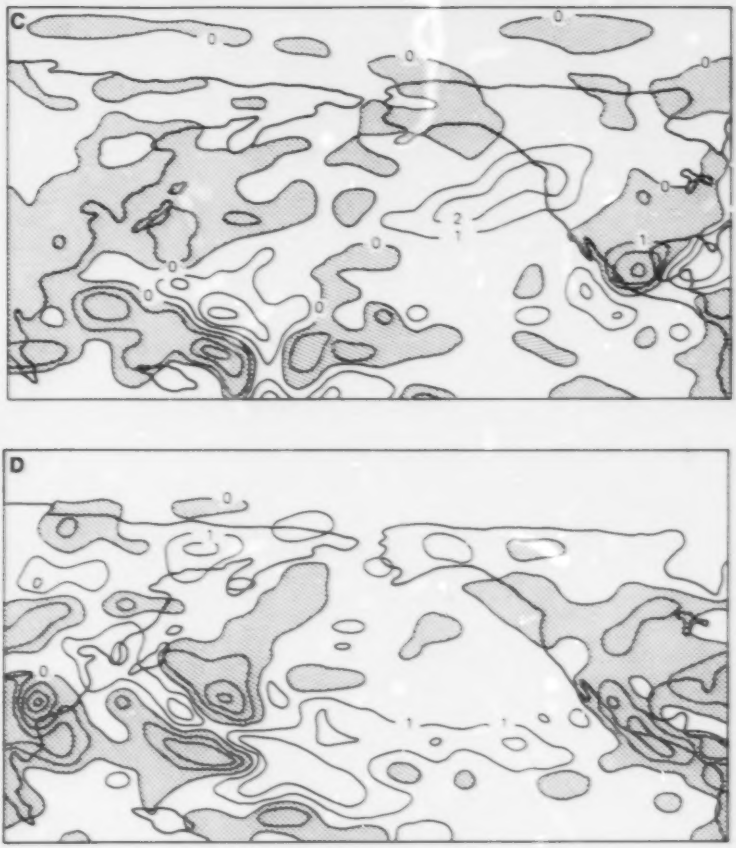

Figure 8 (continued).

Models predict a weaker north-south pressure gradient and hence weaker westerly winds. There are also indications of shifts in major pressure systems such as an eastward shift of the Aleutian Low in winter and increasing pressures over the Gulf of Alaska in summer. Some models show a general reduction in day-to-day and interannual variability in mid-latitude storm tracks in winter. However, these results vary from model to model and no strong conclusions are possible.

An indirect influence on the ocean arises due to changes in precipitation and temperatures over land causing changes in river runoff. Since precipitation and soil moisture are poorly modelled, runoff results are not yet very reliable. However, since the precipitation is predicted to increase in winter over western North America and parts of Asia, some increase in runoff will be expected.

Spring maximum runoff would be expected to occur earlier due to warmer temperatures. Both these results would have impacts on the circulation and ecology of the coastal waters. The retreat of sea ice in the Bering Sea in winter and increase in the length of the ice free period would both have major impacts on the ecology and physical oceanography of the region.

POSSIBLE IMPACTS ON MARINE RESOURCES

The impacts of climate change on the oceans and coastal zones, due to sea level rise and changes in the ocean itself, have been examined by Working Group II of the IPCC (1990; IPCC II) and are represented schematically in Figure 9. Consider first some of the impacts of sea level rise. Coastal areas are inherently hazardous areas which, at the same time, continue to increase their concentrations of people and economic activities. Impacts of a 1 m rise in sea level have been the standard for impact assessment studies although such a rise seems unlikely over the next 100+ years. A 1 m rise would result in, for example, 17 per cent of Bangladesh's arable land being inundated (Commonwealth Secretariat 1989) and large displacements of population in Indonesia and Vietnam. Flat deltaic areas are most vulnerable, with the most critical around the North Pacific being the Yangtze and Hwang Ho in China and the Mekong in Vietnam. Coral atoll nations, such as the Marshall Islands, are particularly at risk. Sea level rise would also affect the agricultural productivity of these countries both through inundation and salt water intrusion. Water supplies will be affected by salt water advance inland in both aquifers and estuaries. Some atoll nations rely on rainwater lenses for water supplies. Small increases in sea level will cause significant decreases in the size of lenses.

Rising sea level increases the risk of flooding because: there is a higher base for storm surges; natural defences due to beaches, sand dunes and marshes would be eroded away; and there is an increased likelihood of river surges (Titus *et al.* 1987). Damage to coastal infrastructures could be in the hundreds of billions of dollars. There will be a general physical deterioration of coastal regions due to erosion, inundation and recession of barrier islands, coastal atolls and other shorelines. Many recreational beaches would be eliminated and costs of maintaining navigation channels greatly increased.

Rising sea level will have a very large impact on the ecological regimes of beaches, estuaries and wetlands. Over two-thirds of fish caught for human consumption and many birds and terrestrial animals rely upon coastal marshes and swamps for part of their life cycles. Although wetlands can adjust to a slow sea level rise, a faster rate could lead to their destruction. Further, if dykes or bulkheads intervene, the wetlands can not move inland, leading to their elimination (Titus 1990).

Direct impacts on the ocean are harder to quantify. A general decrease in the winds over the ocean would lead to a reduction in the area and intensity of ocean upwelling (Mitchell 1988). However, because lands are predicted to warm faster than oceans, there will be an increase in temperature gradients across coastal regions that can intensify the along-shore stress on the ocean

surface with accompanying acceleration of coastal upwelling (Bakun 1990). These changes would be accompanied by major changes in marine productivity. Which process will dominate for which region is not yet clear.

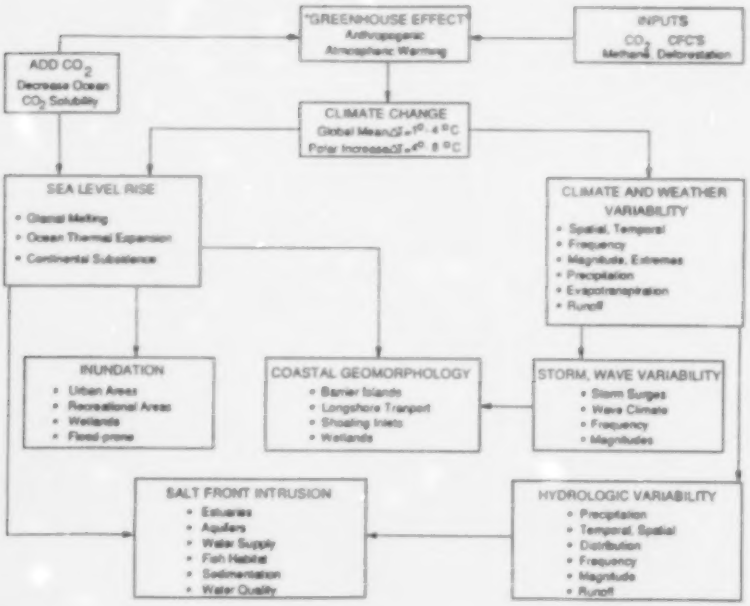

Figure 9. Schematic impacts of climate change on the ocean and coastal zones. From IPCC II.

As noted above, greenhouse gas warming will have an effect on the oceanic carbon cycle. A direct effect of increasing atmospheric CO_2 concentration would be to increase sea water acidity by up to 0.3 pH units. This and related processes could decrease the stability of complexes of trace metals with effects on marine organisms.

An increase in oceanic temperatures will result in a shift northward of ocean climatic zones with impacts on fish and other species. It is possible that significant impacts on world fisheries could occur. Warmer waters will also intensify the biodegradation processes while the increase in UV-B radiation, resulting from the depletion of the ozone layer (a related environmental problem) could accelerate bacterial and photochemical degradation of pollutants. These are complex interactions and their overall impacts are not clear (IPCC I). The highly productive fisheries regions, such as the Bering Sea, need to be further studied.

SUMMARY

It is clear that climate change will have an impact on the marine resources of the North Pacific Ocean but the details are not clear. It is possible that the net impacts could be positive but it is important that better answers be obtained for these important questions. At the Second World Climate Conference (October-November 1990), nations of the world will review the results of the assessments by the IPCC and, hopefully, initiate the process of inter-governmental negotiations leading to a global climate convention.

BIBLIOGRAPHY

Barnett, T., 1984: The estimation of "global" sea level change: a problem of uniqueness. *J. Geophys. Res.*, 89, 7980-7988.

Bakun, A., 1990: Global climate change and intensification of coastal upwelling. *Science*, 247, 198-201.

Boer, G.J., MacFarlane, N.A., and Lazare, M., 1991: Greenhouse gas induced climate change simulated with the CCC second generation GCM. *J. Climate* (submitted).

Broecker, W.S., 1987: Unpleasant surprises in the greenhouse. *Nature*, 328, 123-126.

Broecker, W.S., Peteet, D. and Rind, D., 1985: Does the ocean-atmosphere system have more than one stable mode of operation? *Nature*, 315, 21-35.

Commonwealth Secretariat, 1989: Climate Change: Meeting the Challenge. Report by a Commonwealth Group of Experts, London.

Elliott, W.P., and Reed, R.K., 1984: A climatological estimate of precipitation for the World Ocean. *J. Climate Appl. Meteor.*, 23, 434-439.

Emmanuel, K.A., 1987: The dependence of hurricane intensity on climate. *Nature*, 326, 483-485.

IPCC I, 1991: Climate Change: The IPCC Scientific Assessment. Cambridge Univ. Press, 364 pp.

IPCC II, 1990: Potential Impacts of Climate Change. WMO-UNEP, (to be published).

LeBlond, P.H., and Thomson, K.A., 1992: The North Pacific Ocean Environment. *Trans. Royal Soc. Can.*, (this volume).

Mitchell, J.F.B., 1988: Local effects of greenhouse gases. *Nature*, 332, 399-400.

Mysak, L.A., 1986: El Niño, interannual variability and fisheries in the northeast Pacific Ocean. *Can. J. Fish. Aquatic Sciences*, 43, 464-497.

Ramanathan, V., Backstrom, B.R., and Harrison, E.F., 1989: Climate and the earth's radiation budget. *Physics Today*, 42, 22-34.

Stewart, R.W., Kjerfve, B., Milliman, J. and Dwivedi, S.N., 1990: Relative sea-level change: a critical evaluation. *UNESCO Rpts Marine Science*, 54, 22 pp.

Stouffer, R.J., Manabe, S., and Bryan, K., 1989: Interhemispheric asymmetry in climate response to a gradual increase of atmospheric carbon dioxide. *Nature*, 342, 660-662.

Tabata, S., 1965: Variability of oceanographic conditions at Ocean Station P in the northeast Pacific Ocean. *Trans. Roy. Soc. Can.*, Vol. III, Series IV, 367-418.

_____, 1975: The general circulation of the Pacific Ocean and a brief account of the oceanographic structure of the North Pacific Ocean, Part 1 — circulation and volume transports. *Atmosphere*, 13, 133-168.

_____, 1976: The general circulation of the Pacific Ocean and a brief account of the oceanographic structure of the North Pacific Ocean, Part 2 — thermal regime and influence on the climate. *Atmosphere*, 14, 1-27.

Thomson, R.E., and Tabata, S., 1989: Steric sea level trends in the Northeast Pacific Ocean: possible evidence of global sea level rise. *J. Climate*, 2, 542-553.

Titus, J.G., 1990: Greenhouse effect, sea-level rise and barrier islands. *Coastal Management*, 18, 1.

Titus, J.G., Kuo, C.Y., Gibbs, M.J., LaRoche, T.B., Webb, M.K., and Waddell, J.O., 1987: Greenhouse effect, sea-level rise and coastal drainage systems. *J. Water Res. Planning and Management*, 113, 2.

Wooster, W.S. (ed.), 1983: *From Year to Year: Interannual Variability of the Environment and Fisheries of the Gulf of Alaska and the Eastern Bering Sea*. Univ. Washington, Seattle, 208 pp.

WARREN S. WOOSTER*

Marine science and resources: international issues and opportunities†

Use of the ocean and its resources faces many constraints which both create international issues and characterize their solutions. Natural constraints are particularly salient for living resources whose quantities and availability are usually variable and seldom predictable. The extent to which production is governed by harvest rates, by interactions with other species, and by environmental conditions is far from clear, even after more than a century of research. That such constraints remain poorly understood is a measure both of their complexity and of the low priority given to their investigation.

Another class of constraints arises from the interplay between the limits of national jurisdiction and the dynamics of ocean behaviour. Neither fish nor ocean currents pay any attention to the lines we draw on water, so the amicable allocation and jurisdiction over resources and other uses of the ocean depend on agreement among the users.

The framework for these agreements was set by the 1982 Convention on the Law of the Sea. Although the Convention is not in force and has even been rejected by some major countries, its provisions — except for those applying to mineral resources of the deep seabed (in many ways a hypothetical question, at least for the next few decades[1]) — are widely accepted.

The most striking innovation of the lengthy negotiations was creation of the Exclusive Zone, the extension of national jurisdiction over resources and marine scientific research out to 200 nautical miles. This provision was inspired by contention, going back to the late 1940s, over coastal state claims to jurisdiction over living resources. Establishment of the EEZ has benefited both coastal states and their resources in many ways, but not all of the effects have been positive.

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† Presented at the symposium, "Marine Resources of the North Pacific", University of Victoria, 6 June 1990.

Fishery management has been drastically altered by the transfer to coastal states of jurisdiction over stocks that previously could only have been managed, if at all, through international arrangements. But this transfer has greatly weakened international fishery commissions leaving them with jurisdiction over a much reduced fraction of the living resources in the ocean. At the same time, a serious discrepancy has emerged between the needs for international cooperation in living resource study and management and the capabilities of the present organizations intended to handle that responsibility.

The impact on marine scientific research has been less obvious. Worst-case scenarios of total coastal state control over research have suggested the likelihood of scientific paralysis. In fact, this has not happened, at least in the northern North Pacific where political relations between research and coastal states have tended to improve in recent years (e.g., note recent U.S. access to Soviet waters).

The Convention left unresolved some matters relevant to this symposium, among them the precise manner in which shared and straddling stocks of living resources are to be managed. Cases in point are present controversies over fisheries in the international area of the Bering Sea (do the pollock stocks in the "doughnut hole" mix with those farther east and west, and how should they be protected and allocated?) and over the high seas drift net fisheries (what is the impact of such fisheries on squid, salmon, and mammals, and how can they most effectively be managed?). Note that in both cases, rational policy decisions depend on scientific information that does not now exist.

REASONS AND CONDITIONS FOR INTERNATIONAL SCIENTIFIC COOPERATION

While legal and jurisdictional constraints support the need for international scientific cooperation if national ocean interests are to be pursued most effectively, the most compelling reasons for such cooperation arise from the realization that marine science in general and its applications to studies of climate change and its effects, fisheries, and marine pollution are all inextricably intertwined. For example, the answers to pressing fishery questions require investigations that go beyond fisheries *per se* and include obtaining information on environmental changes that dominate variability in the distributions and abundances of fish stocks. Furthermore, even local phenomena, for example within the EEZ, are influenced from afar, by events taking place in other jurisdictions.

There is ample evidence that environmental change influences the success of recruitment to fish stocks. While year to year changes in stock abundance can sometimes be linked with specific events (e.g., El Niño) or environmental variables (e.g., the intensity of offshore transport or turbulent mixing), it is presumably some concomitance of favourable conditions that leads to strong year classes. On a longer time scale, large scale changes in community structure and in population distribution and abundance appear to relate to

trends of environmental conditions, often over scales of several thousands of kilometres or more.

It is important to understand the nature and magnitude of the environmental influence on the abundance of populations not only because of the possibility of forecasting trends in recruitment and thereby avoiding unpleasant surprises in fisheries, but also because of concern over the impact of man-induced climate alteration and the limits this may place on the future utilization of marine living resources. Human activity appears to be causing climate change of greater magnitude and at a faster rate than that of the recent past. Questions are being raised about the likely effects of such changes on marine biota, and especially on fish stocks. Even with the environmental changes already experienced during the last hundred years, fish stocks have crashed or exploded, and have relocated and been replaced, with notable consequences for the societies dependent on their exploitation.

Because of the scale of these phenomena, the capabilities of several countries must be pooled if the necessary research is to be accomplished. Furthermore, the scientific problems require the attention of atmospheric and fishery scientists and of oceanographers of biological, chemical and physical persuasion. Knowledge is required of changes in the atmosphere and ocean circulation, in plant and animal production, and in interactions among organisms in the common ecosystem. Such information can come from many sources, from meteorological and oceanographic services and from academic scientists as well as from fishery laboratories. An adequate system for collecting and assessing such information requires the participation of scientists from all the relevant disciplines, laboratories, institutions, and countries involved.

ON OBTAINING CREDIBLE SCIENTIFIC ADVICE

In considering the adequacy of institutional arrangements for scientific cooperation in the face of the new regime of ocean management, particularly of marine living resources, one of the most compelling needs is for credible scientific advice.

The management of these resources involves both conservation and allocation, the latter particularly making it difficult to obtain unbiased scientific data and analyses on which to base the management decisions. To meet this problem, two approaches have been followed. In one, the management body has its own scientific staff whose independent analyses can be compared with those of national laboratories. The Inter-American Tropical Tuna Commission and the International Pacific Halibut Commission are examples.

The other approach, exemplified by the International Council for the Exploration of the Sea (ICES) and the fisheries bodies that it advises, is to carry out scientific assessment in an organization distinct from that responsible for management. In this model, scientific research is done nationally while data and analytical efforts are pooled to provide the information needed for management. The trick here is to decouple scientific and political action and to de-nationalize the scientific analysis so that its findings are credible.

Independent scientific analysis has the advantages that it is more likely to be objective and to be based on the most current and realistic data. It is also far more likely to be able to go beyond traditional fishery data to take into account interactions with other species as well as the consequences of environmental (climate) change for the distribution, abundance, and productivity of fish stocks.

ISSUES, OPPORTUNITIES, AND DIFFICULTIES

The principal issues arising from all this could be summarized as follows. First, changes in national jurisdiction affect the use of living resources and their management and the conduct of marine scientific research. Second, the need for ocean research and monitoring has become more salient with the concern over climate change, the effects of human activities, and problems with the variable supply of resources.

These issues are accompanied by some opportunities. First, scientific and technological advances (e.g., remote sensing, improved computer capability and models, more effective interaction among the marine sciences and between them and other disciplines) promise to accelerate the achievement of scientific understanding of the ocean and its application to practical problems. Second, national recognition of the issues described above and improved relations among the countries involved promise more effective scientific cooperation and facilitate putting together more effective international institutions.

SOME PRINCIPLES OF INSTITUTIONAL DESIGN

Existing organizations in marine science and fishery management are poorly matched to their objectives, often have too narrow a focus on only limited aspects of their remits, and usually fail to recognize the broad range of forces that drive the system with which they deal. If more effective institutions are to be designed, there are some general principles on the functioning of international organizations that should be kept in mind.

Geographical coverage

As one passes from local to regional to global scope, the treatment of any subject tends to become either more superficial or more expensive. As more countries become involved, the stake of each is diminished, and additional political problems arise. Global and regional organizations tend to serve different functions. In the fields of interest to this symposium, global organizations have broad objectives and global interests. Their priorities are often dominated by the interests of the majority of their members, the developing countries. Regional organizations, on the other hand, usually have more restricted objectives and their interests reflects those of their limited membership.

Degree of specialization

In passing from highly specialized to very general, more kinds of specialists and agencies of government are involved. Problems of immiscibility of different kinds of specialists arise, and the adequacy of interagency coordination at the national level becomes critical.

Many international organizations are concerned with some aspect of marine affairs. One global organization, the Intergovernmental Oceanographic Commission, deals exclusively with marine science; others are active in related fields, e.g., Food and Agriculture Organization (FAO) (fisheries), World Meteorological Organization (WMO) (meteorology), and the United Nations Environmental Program (UNEP) (pollution). These organizations are specialized in ways that relate to, but do not comprehend the problems I have been discussing. There are also a few regional intergovernmental bodies concerned with marine science, the oldest and best known being ICES in the eastern North Atlantic.

Since regional fishery commissions are dependent on scientific information as a basis for their decisions, they might seem the logical bodies to promote the necessary scientific studies. However, the specialization in fisheries, usually of a small number of species, has tended to isolate them not only from questions of interaction with other species (over which they have no jurisdiction) but also from other aspects of science now seen to be relevant, most notably from the environmental sciences.

Degree of formality

This extends from personal and informal through non-governmental to intergovernmental. With increasing formality, flexibility decreases, costs and response time increase; on the other hand, access to government funding and government commitment may also increase. For a given set of issues, the trade-offs become critical.

Marine scientific research, like any other scientific research, is done by individual scientists, usually with the help of national financial and other resources and institutional arrangements. The efficacy of arrangements for getting scientific work done tends to vary inversely with the degree of formality, and scientists usually prefer the least formal arrangements that will do the job. While this leads scientists generally to work with non-governmental organizations, involvement of governments is often necessary to provide financial and other resources and to make possible the exchange of economically sensitive data and information. There are important problems where the scope of universal intergovernmental organizations can be brought usefully to bear in support of marine scientific research. It must be recognized, however, that the transaction costs of dealing with such organizations, which are often heavily bureaucratized, can be large.

Effects of linkages

The special interests of an organization determine the national agencies with which they have contact. As the scope of problems broadens, serious mis-

matches may arise, particularly when national interagency coordination is ineffective.

The basic work of concern to international organizations is usually done at the national level with the organization serving the purposes of promotion, coordination, and information exchange. However, within most countries, atmospheric, fisheries, oceanographic, and pollution investigations are conducted in different agencies and university departments. These various centres of activity are often poorly coordinated, and this lack of coordination carries through to the international institutions that support cooperative scientific ventures.

It has been said that the marine programs of Unesco and FAO suffer from domination of the former by pedagogues (and their Ministries of Education), the latter by farmers (and their Ministries of Agriculture). Other examples include WMO (weather bureaus) and the International Hydrographic Organization (hydrographic offices). As the holistic nature of scientific questions in the ocean becomes more apparent, so does the inadequacy of present institutional arrangements, especially as they reflect lack of coordination at the national level.

National lead agencies are commonly designated for contact with one or another international organization. Which agency leads in a given country is a function of the structure of the government with regard to the activity of the organization and the nature and degree of specialization of that activity. What is needed is a mechanism within each country linking the agencies concerned with key elements of the international organization's program. These would include academic and government research in oceanography, fisheries, atmospheric science, and marine pollution. The mechanisms should ensure appropriate participation in the organization's activities so that its goals can be met and the government's interests thus served.

NEW ORGANIZATIONS NEEDED IN THE NORTH PACIFIC

Returning now to the issues and opportunities discussed earlier, I postulate that there are two kinds of regional organizations that should be developed to facilitate international cooperation in the study and use of the ocean and its resources in the North Pacific. The first, needed to strengthen scientific understanding, would have the following characteristics:

1. Geographical coverage — regional; northern North Pacific including temperate and subarctic zones along with adjacent seas.
2. Specialization — oceanography; related meteorology and climatology; fishery science.
3. Formality — intergovernmental but with informal scientific component.
4. Linkages — with national agencies and universities concerned with ocean and fishery sciences, meteorology and environmental monitoring, environmental quality.

The organization should concern itself with studies of changes in atmospheric and oceanic circulation, especially of scales extending from seasons to decades, and of the response of the oceanic biota, including although not limited to stocks of marine vertebrates and invertebrates of commercial interest, to environmental change and to human activities. Its role would be to promote the exchange of information and data, to identify and facilitate research on problems deemed important by its members, and where appropriate to arrange for collaborative analysis of available data and information in response to the requests of its members or of other organizations. Important steps have been taken in the last few years towards establishing such an organization, a north Pacific marine science organization often called "PICES".

The second organization, needed to improve management of the use of living resources, must be distinct from the marine science organization because of the inherent incompatability between its management responsibilities and the objective search for understanding. It would have the following characteristics:

1. Geographical coverage — regional; northern North Pacific including temperate and subarctic parts along with adjacent seas.
2. Specialization — fishery science and management for all shared stocks of commercial interest in the region.
3. Formality — intergovernmental organization.
4. Linkage — with national fishery management agencies.

While it may be argued that for problems of shared stocks there continues to be a need for bilateral organizations such as the IPHC and the Pacific Salmon Organization, management problems of straddling stocks or those principally located on the high seas call for a broadly based management organization with membership from countries involved in the high seas fisheries and concerned with the full set of species involved. To obtain the objective assessment of underlying scientific data, this organization should collaborate closely with the scientific organization referred to above. Progress is being made toward broadening membership of the existing International North Pacific Fishery Commission, but unfortunately extension of consideration beyond the high seas salmon fisheries seems not yet to be contemplated. A new INPFC without a broadened perspective is not likely to meet the international fishery management needs of the coming decades.

ENDNOTES

1. Coastal state jurisdiction over mineral resources of the continental shelf was already established by 1958 Convention.

Award Winner
Lauréat médaillé

THE FLAVELLE MEDAL ADDRESS
L'ALLOCUTION DE LA MÉDAILLE FLAVELLE

PETER W. HOCHACHKA, F.R.S.C.*

Seals: Diving To The Edge Of Hypoxic Crisis†

Animal extremists are one of my favourite kinds of study organisms for two simple but important reasons. Firstly, in pure biology they supply us with interesting solutions for surviving harsh environmental stresses and for identifying defense strategies against specific hostile parameters of the environment. Secondly, they supply insights into parameters which are adjustable *vs* those which are necessarily conservative (i.e. insights into modern paradigms of evolution and biochemical adaptation). As a kind of spinoff, the study of animal extremists also is useful for applied biology and medicine because it supplies us with potential blueprints and intervention strategies for dealing with similar stresses in different (e.g. clinical) settings. In this short essay, I will focus on one particular group of such animal extremists — the Weddell seal of the Antarctic and other large seals — which are exquisitely adapted for diving that is so deep and so long that oxygen supplies become potentially limiting. How do they balance their 0_2 supplies with 0_2 demands under these extreme conditions?

THE 1990s DIVING PARADOX

The literature and international symposia on diving metabolism and physiology trying to answer this question were greatly enlivened during the 1980s by an apparent paradox: a seeming discordance between laboratory and field data on the significance of the Scholander diving response. With the development of microcomputer assisted measuring devices, spear-headed to a major degree by Roger Hill (1), then working with our group, this paradox has been largely resolved, and the dialogue is now far more reserved, implying relatively broad

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agreement between the diverse workers in this area. As we enter the 1990s, however, the same discipline is confronted with another and equally perplexing paradox: namely, **the apparent ability of large (Weddell, southern elephant, and northern elephant) seals to dive for time periods that are longer than their aerobic diving limits (ADLs), the time periods required for resting metabolic rates (RMRs) to consume all onboard O_2 supplies (2,3,4,5,6).** The current depth record (obtained in northern elephant seal studies) is 1.25 km (6), while the time record (observed in studies of the southern elephant seal) is 2 hrs, or 3-4 times the ADL (3; Hindell, pers. comm.). The simplest explanation of such data is that the seals are hypometabolic during diving, despite the fact that they are swimming (either, foraging or migrating, both of which are energy expensive processes). What is more, the field data currently available (2,6) indicate that these large seals when at sea are submerged close to 90 per cent of the time for periods of weeks or months each year. Hence living in 'the slow lane' (i.e. hypometabolism) is seemingly a normal state of affairs for these species, and my main goal in this analysis is to lay some of the groundwork for understanding the phenomenon at fundamental metabolic and physiological levels.

BACKGROUND

Antecedents to this paradox are evident in the literature as far back as the late 1930s [work of Scholander and Irving (see 7)], but are based on laboratory experimentation. We first confronted the problem in our 1982/1983 studies of voluntary diving in Weddell seals [see Guppy *et al* (4), and Qvist *et al* (5)]; our data show that for some dives the amount of onboard O_2 available can only sustain rather low metabolic rates, lower than RMR. Less than predicted amounts of lactate formed during such dives (released into the blood after such dives) indicate that the energetic deficit is not being made up by anaerobic glycolysis. Thus we conclude that the data are consistent with a relatively hypometabolic state during diving (4,8). Two later data sets essentially confirm and extend this interpretation. The first on southern (3) and northern (2,6) elephant seals indicates that over 25 per cent of voluntary diving at sea exceeds the so-called aerobic diving limit (the ADL), which is the maximum "aerobic" diving time possible at RMR; because in these diving patterns, the animals spend about 90 per cent of their time submerged and typically display very short time intervals at the surface, it is generally assumed that their reliance on anaerobic glycolysis must be minimal, as in the Weddell seal studies (4,8,9). Thus, the most plausible explanation of these data also assumes a relatively hypometabolic state at least during long dives (2,6). The second data set bearing on this issue arises from laboratory experiments in which northern elephant seals are allowed to dive whenever they wish for as long as they wish; average metabolic rates are determined by gas exchange measurements when the animals surface. These data show that the longer the dive, the lower the metabolic rate (Le Beouf, pers. comm.), in agreement with analogous field measurements on Weddell seals comparing dive plus interdive metabolic rates

to 0_2 consumption rates measured while the seals are resting or sleeping at the breathing hole (10).

To be sure, not all marine mammals necessarily show this behaviour. Currently, at least two general patterns can be discerned which seem to be determined by the way in which the metabolic demands of diving and of swimming exercise are balanced, and gradations between them are clearly possible and probable. In high performance species (dolphins, penguins, sea lions), the exercise demands of high swimming velocities would be expected to swamp out any savings that are possible by metabolic suppression strategies of the large seals (8,11). That is why it is not surprising to find field metabolic rate estimates of such species to be substantially above RMR [see for example (12)], rather than below it. These measurements utilize the doubly labelled water technique for measuring average metabolic rates usually over periods of days to weeks, so the relationships between dive duration and metabolic rate are not known. Nevertheless, the contrasts between the two different (fast lane *vs* slow lane) life strategies of marine mammals are evident and lead to interesting ecological implications; some of these are reviewed elsewhere [e.g. (13)] and are not really central to our own study. They are mentioned here because they illuminate boundary conditions in the marine mammal world: the energy dissipative strategies of fast swimming species *vs* the energy conserving strategies of the large seals. In the former, where the demands of exercise are dominant, energy sinks; the metabolic picture is presumably fairly analogous to that in exercising terrestrial mammals and man, and is intuitively easy to understand. In the latter, however, the situation is seemingly counter-intuitive: swimming and foraging at sea at metabolic rates potentially suppressed below RMR. How can this be achieved?

TWO-PRONGED STRATEGIES OF SURVIVAL

At the biennial marine mammal conference in Asilomar in December 1989 there was widespread agreement on one issue: namely, that at the moment there is no theoretical framework available that can adequately account for the above 'life in the slow lane' paradox. From studies of other organisms adapted for living at the edge of hypoxic crisis, we know that (i) minimizing energy demands (thus metabolic rates) and (ii) maximizing efficiencies of various energy-consuming biochemical and biomechanical processes are dominant survival strategies (16,17). Indeed, such two-pronged strategies give biological meaning to the observed behaviour of seals during voluntary diving. However, sorting out underlying mechanisms is not an easy matter. When studying seals in a natural marine setting, it is particularly difficult to get an experimental wedge into mechanisms underlying efficiency adaptations. That is why, for now, at least, most efforts tend to concentrate on the first option: how metabolic rates (and thus biological energy demands) can be minimized. Even here, our current analyses are necessarily tentative and based to large degree on land animals.

INTERPRETIVE MODEL

In studies of metabolic regulation during exercise in numerous terrestrial mammals exquisite matching between perfusion (O_2 and fuel delivery) and muscle metabolic rate is typically observed. This close relationship, evident at the local tissue level as well as at the global [cardiac output/VO_2 level (14)], characteristically begins at RMR and moves up towards VO_2(max). For heuristic reasons, we propose that during voluntary diving in large seals such as the Weddell this relationship also holds where, from RMR, it moves down to lower values, as is frequently reported in ischemia in peripheral tissues and organs (15,16). **Metabolic rate and perfusion rate in this context can be considered to be expressions of the same phenomenon (O_2 flux) under both hypo- and hyper-metabolic conditions.** If correct, this model suggests that metabolism during diving in large seals is suppressed because perfusion of specific tissues and organs is suppressed; i.e. suppressed perfusion is the proximate cause of suppressed metabolism of peripheral tissues and organs. It should be added that this is not totally new; echoes of such concepts are to be found in much of the earlier literature on forced submergence in seals and other aquatic mammals and birds [see (18,19)]. My reason for emphasizing the concept in this analysis stems from the known endocrine controls of perfusion-metabolism coupling in both exercise (20) and forced submergence (21) settings.

THE ENDOCRINOLOGY OF DIVING MARINE MAMMALS: A DISCIPLINARY HIATUS

While measurements of tissue perfusion and tissue metabolism in large seals are not readily made at sea, the measurement of plasma hormone concentration profiles during diving and recovery is, in principle, a relatively easy matter. At this time, however there are no reports on the hormonal status of seals or other marine mammals during voluntary diving in the natural environment — a true hiatus in the field. Available data on diving animals apply to forced submergence (22,23) with possible fright and maximum diving responses potentially confounding the results. Because the slate is so clean at the outset, our choices for analysis during diving revolve around those hormones which, from studies of either terrestrial animals or of forced diving, are known to be involved in the regulation of perfusion. Of these, epinephrine and norepinephrine are of particular interest for two reasons: (i) they are known to increase drastically during forced submergence in ducks (21,23) and seals (25), where they are thought to extend the sympathetically mediated vasoconstrictions in peripheral tissues into the hypoxic zone, and (ii) they are thought to be involved in perfusion-metabolism coupling both in terrestrial mammals (20) and especially in forcibly submerged aquatic ones (21).

In this connection, studies of forced submergence indicate that perfusion of the adrenal gland is largely sustained [40 per cent drop in the Weddell seal, a modest change compared to the vasoconstrictions observed in most

peripheral tissues (18)], which is consistent with a recent indepth analysis in ducks showing that essentially 100 per cent of the epinephrine rise (and 40-80 per cent of the norepinephrine rise) during submergence is derived from the adrenals (21).

Because it is more prudent to probe this problem area within the framework of a predictive and testable hypothesis, it is proposed that in voluntarily diving large seals, **working metabolic rates are integrated with dive duration through catecholamine regulation of degree of vasoconstriction (i.e. of degree of tissue perfusion). In general, the longer any individual dive, the longer the requirement for vasoconstriction, the higher the plasma concentrations of catecholamines required, and the lower the metabolic rate (i.e. the lower the 0_2 consumption rate of hypoperfused tissues).** With respect to the catecholamines, this hypothesis makes clearcut and testable predictions, and rationalizes already available data on simulated diving in both marine mammals and birds.

Additional clues as to the relationship between diving duration and tissue perfusion adjustments may arise from the analysis of other modulators of tissue perfusion. Two particularly exciting possibilities are the endothelium-derived vasodilator, nitric oxide, and the vasoconstrictor, endothelin (26). The former has a very short half-life (27) and cannot be investigated in voluntarily diving seals; the latter however is more stable. Endothelin displays its pressor responses at concentrations in the nannomolar range and increases in concentration under conditions of ischemia or other stresses characterized by flow restrictions [Yanagisawa, pers. comm.; (28)]. Whereas we do not have as strong a theoretical framework for the effects of this kind of perfusion (and hence metabolism) regulator, the expectations here are similar to those described for the catecholamines; namely, the longer the diving duration, the higher the transient concentration of endothelin. Again, the unequivocally predictive nature of the model is obviously advantageous.

Finally, in considering hormonal responses to voluntary diving at sea it is important to include thyroxine (T4), triiodothyronine (T3), and thyroid stimulating hormone (TSH). This is because background research on other mammals suggests that thyroid hormones may be involved in the setting of metabolic rates of many tissues (29) and the energetic efficiency of working muscle (30). Obviously the peculiar at-sea hypometabolism of the large seals, as well as their seemingly up-regulated metabolic efficiencies, could be influenced by thyroid hormone concentrations and/or turnover rates. To my knowledge the turnover rates of these hormones have never been measured in any seals, not alone the large species of interest in this essay, and there are no measurements of their concentrations during prolonged periods of voluntary diving at sea. While short-term T4/T3 regulation of metabolism is not normally observed in the mammals (30) and is not expected in seals, obtaining such measurements on large seals while diving voluntarily at sea should nevertheless supply extremely useful information. Whether or not researchers can rise to the challenge of such a task remains to be seen.

SUMMARY

1. Despite the energetic costs of swimming (foraging or migration), large seals are able to dive longer than is required for resting metabolism to use up all available oxygen supplies; i.e., large seals frequently seem able to dive longer than should be allowable on the basis of oxygen availability.
2. The most parsimonious explanation of such data assumes that during voluntary diving at sea large seals are relatively hypometabolic, minimizing energy demands while maximizing work and metabolic efficiencies.
3. Little is known about how efficiencies are up regulated. However, metabolic suppression is thought to depend upon (hormonally mediated?) perfusion adjustment of vasoconstricted tissues and organs.
4. Little is known concerning which organs and tissues are hypoperfused (and are hypometabolic) during prolonged diving. However, it is clear that the energetic demands of cell work functions must fall in proportion to metabolic suppression, a problem area that is explored elsewhere (31).

ENDNOTES

1. Hill, R.D. (1986) *J. Appl. Physiol.* 61, 1570-1576.
2. LeBeouf, B.J., Costa, D.P., Huntley, A.C., Feldcamp, S.A. (1988) *Can. J. Zool.* 66, 446-458.
3. Hindell, M.A., Slip, D.J., and Burton, H.R. (1989) *8th Biennial Conf. on the Biol. Marine Mammals ABSTRACTS*, pp 29.
4. Guppy, M., Hill, R.D., Schneider, R.C., Qvist, J., Liggins, G.C., Zapol, W.M. & Hochachka, P.W. (1986) *J. Appl. Physiol.* 250, R175-R187.
5. Qvist, J., Hill, R.D., Schneider, R.C., Falke, K.J., Liggins, G.C., Guppy, M., Elliot, R.L., Hochachka, P.W., & Zapol, W.M. (1986) *J. Appl. Physiol.* 61, 1560-1569.
6. LeBeouf, B.J., Naito, Y., Huntley, A.C., and Asaga, T. (1989) *Can. J. Zool.* 67, 2514-2519.
7. Scholander, P.F. (1940) *Hvalradets Skr.* 22, 1-131.
8. Hochachka, P.W. (1986) *Fed. Proc.* 45, 2948-2952.
9. Kooyman, G.L., Castellini, M.A., Davis, R.W., and Maue, R.W. (1983) *J. Comp. Physiol.* 151, 171-174.
10. Castellini, M.A. and Kooyman, G.L. (1989) *Undersea Biomed. Res.* 16, 355-362.
11. Hochachka, P.W. (1989) *8th Biennial Conf. on the Biol. Marine Mammals ABSTRACTS*, pp 29.
12. Davis, R.W., Croxall, J.P., and O'Connell, M.J. (1989) *J. Animal Ecol.* 58, 59-74.
13. Gentry, R.L. and Kooyman, G.L. (1986) (eds.) *Fur Seals: Maternal strategies on land and at sea.* Princeton, N.J.: Princeton University Press.

14. Wasserman, K., Beaver, W.L. and Whipp, B.J. (1990) *Circulation (Suppl. II)* 14-30.
15. Meren, H., Matsumura, T., Kaufman, F.C., and Thurman, R.G. (1986) in *Oxygen Transport to Tissue*, Vol. 8, 487-496.
16. Hochachka, P.W. and Guppy, M. (1987) *Metabolic Arrest And The Control of Biological Time*. Cambridge, Mass.: Harvard University Press.
17. Hochachka P.W., Stanley, C., Matheson, G.O., McKenzie, D.C., Allen, P.S., & Parkhouse, W.S. (1991) *J. Appl. Physiol.* 70, 1720-1730.
18. Zapol, W.M., Liggins, G.C., Schneider, R.C., Qvist, J., Snider, M.T., Creasy, R.K., & Hochachka, P.W. (1979) *J. Appl. Physiol.* 47, 968-973.
19. Butler P.J. and Jones, D.R. (1982) *Adv. Comp. Physiol. Biochem.* 8, 170-364.
20. Bove, A.A. (1989) *News Physiol. Sciences* 4, 143-146.
21. Lacombe, A.M.A. (1990) *Effects of circulating catecholamines on diving in ducks*. PhD Thesis, The University of British Columbia, Vancouver, Canada.
22. Hochachka, P.W., Murphy, B.J., Liggins, G.C., Zapol, W.M., Creasy, R., Snider, M., Schneider, R., & Qvist, J. (1979) *Nature* 277, 388-389.
23. Liggins, G.C. (1979) *Acta Endocrinol.* 90, 718-726.
24. Mangalam, H.J., Jones, D.R., and Lacombe, A.M.A. (1987) *Am. J. Physiol. 252: R1143-R1147.*
25. Hance, A.J., Robin, E.D., Halter, J.B., Lewiston, N., Robin, D.A., Cornell, L., Caliguiri, M., & Theodore, J. (1982) *Am. J. Physiol.* 242: R528-R532.
26. Daniel, T.O. and Ives, H.E. (1989) *News Physiol. Sci.* 4, 139-142.
27. Marletta, M. (1989) *Trends Biochem. Sci. (TIBS)* 14, 488-492.
28. Onizuka, M., Ishikawa, S., Tsukada, H., Yuasa, Y., Miyauchi, T., Ishikawa, T., Yanagisawa, M., Schara, Y., Mitsiu, K., Goto, K., and Hori, M. (1990) *FASEB Journal ABSTRACTS* 38.
29. Hulbert, A.J. (1986) IN *Advances in Physiological Research*. New York: Plenum Publ. Co., pp. 305-319.
30. Hennemann, G. (1986) *Thyroid Hormone Metabolism*. New York: Marcel Dekker.
31. Hochachka, P.W. (1989) *Undersea Biomed. Res.* 16, 375-379.

Biographical Sketches of Deceased Fellows
Notices nécrologiques des membres décédés

LUBA ELEEN

Peter H. Brieger
1898-1983

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

PETER HENRY BRIEGER was a pioneer in Art History as an academic discipline in Canada. His humanistic approach to the work of art, seeing it as the profound expression of a social, intellectual and historical milieu, was passed on through his unforgettable teaching to several generations of students and through the legacy of his cogent, lucid writing.

Born in Breslau on 30 July 1898, the son of Oskar Brieger, a professor of otolaryngology, and his wife Hedwig, Peter Brieger enjoyed early experiences in the cultivated atmosphere of the family home that formed the basis for the richly complex intellectual outlook of the mature scholar. There was music; the bookshelves were filled with the classics, especially of German literature, a particular interest of his family for several generations; their furniture, now in the Fitzwilliam Museum in Cambridge, was designed by Hans Pölzig, an important figure in the early modern movement. At their country home in the Riesengebirge, his father built a theatre and organized family productions of plays, no doubt preparing the way for Peter's eventual understanding of baroque art and of his unpretentious but mesmerizing lecturing ability. A French governess provided command of the language as well as familiarity with another culture. All of his siblings entered into distinguished careers: his brother Frederick was a botanist with an interest in orchids who taught for many years in Brazil; another brother, Ernest, was a specialist in tuberculosis and leprosy at a research institute in Cambridge; their sister Katherine Stern earned two doctorates, one in physics, the other in methods of teaching.

Peter attended the Magdalen classical gymnasium and entered Breslau University in 1916. His education was interrupted by service in the German army, as Unteroffizier in a field artillery regiment, to the end of the war. He participated in battles in Flanders, where he was wounded, and at the Somme, and was awarded the Iron Cross, Second Class. In 1919 he returned to the University of Breslau and, in 1920, he moved on to the University of Munich.

The program of study he followed at Munich gives an indication of the direction of his development at this time. His earlier interest in history and literature are signalled by courses in Pre-Reformation, Counter-Reformation and Modern History. The Germanistic family tradition can be seen in seminars in Old- and Middle-High German, the History of the English Language, and Poetics. His social consciousness as a young post-war German and veteran must have attracted him to a course in Socialism taught by the famous sociologist Max Weber. Finally, we can see a new orientation in his academic interests toward art history, inspired by the lectures of two of the leading art historians of the day: Heinrich Wölfflin (Interpretation of the Alte Pinakothek) and Paul Frankl (New Theories on the Origin and Essence of Mediæval Art). He continued his art-historical studies under Dagobert Frey in Breslau, eventually completing his Doctorate there in 1926 with a thesis directed by August Grisebach on judgments about art in German travel literature. He began writing, at first in local scholarly publications, on eminent figures in history and on local baroque art. At the same time he was preparing his Habilitation thesis on nineteenth-century history painting, defended in 1927 and published in 1930. He was appointed Privatdozent at Breslau University in 1927, a post

he occupied until 1934, interrupted in 1927-28 by a stint as Librarian at the Biblioteca Hertziana in Rome. Another important event during these years was his marriage to Barbara Ritter of Hamburg in 1931, initiating a partnership that nourished and encouraged the humanistic spirit within him.

In 1933, during another stay at the Hertziana, the Briegers were warned that Peter, whose family, though Christian for several generations, was of Jewish origin, had no chance of remaining in a university post in Hitler's Germany, and they decided to leave for England. His license to teach was, indeed, revoked in 1935. The move to England was to have a lasting effect upon his scholarship. Although never abandoning his interest in baroque art, he turned his attention increasingly to English mediæval art. He had always had an affinity for the art of the Middle Ages. The list of his lectures at Breslau leans heavily towards mediæval subects. Barbara Brieger's earliest encounter with him was at a lecture he gave on gothic architecture; like countless future students in Canada, she found the lecture "memorable".

At the Courtauld Institute in London, he lectured on mediæval architecture and "Artgeography", assisted in the library, and studied English monuments. In 1935 there were lectures on German art and literature, delivered in German at Oxford and in his rapidly-improving English at Kings College, University of London, and on fourteenth-century architecture at the Ashmolean. A major undertaking in this period was the preparation of an Atlas of English Mediæval Art. His preparatory work won the admiration of his confrères in England, but the manuscript was unfortunately lost during a sea voyage to Canada in 1939.

The Department of Art at the University of Toronto had been founded by John Alford in 1935, and Peter was invited to teach there the following year, at first on a two-year appointment supported by the Carnegie Foundation. He therefore joined the distinguished group of Jewish and anti-fascist art historians who were to transform the discipline in North America, bringing with them the rigorous research methods and demanding standards they had absorbed in their European universities. He was the only one of this group to stay in Canada. Under his leadership — between 1947 and 1964 as Chair — the Department of Art and Archaeology, later the Department of Fine Art, at Toronto grew to be widely respected in the world of scholarship. He was founding president of the Universities' Art Association of Canada from 1959 to 1964 and Canadian representative to the Comité International d'Histoire de l'Art. He was elected to the Society of Antiquaries, London, in 1959, to the Royal Society of Canada in 1969, and was a member of the Athenæum.

During the war years, Peter spent the summers in Ottawa decyphering intercepted German messages, at the same time continuing his research on English mediæval art. Recognition of his leadership in this field is evident in the invitation to write the volume on the thirteenth century of the *Oxford History of English Art*, a work that remains the standard text to this day. In connection with this book he met with one of the typical experiences of Canadian academics abroad. At lunch at the Biblioteca Hertziana he was asked about his affiliations, and his professorial post at the University of Toronto was greeted with condescension. In reply to his expressed interest in English

mediæval art, his neighbour advised him to read the excellent new volume of the Oxford History, and he was able to reply, "Thank you for the compliment".

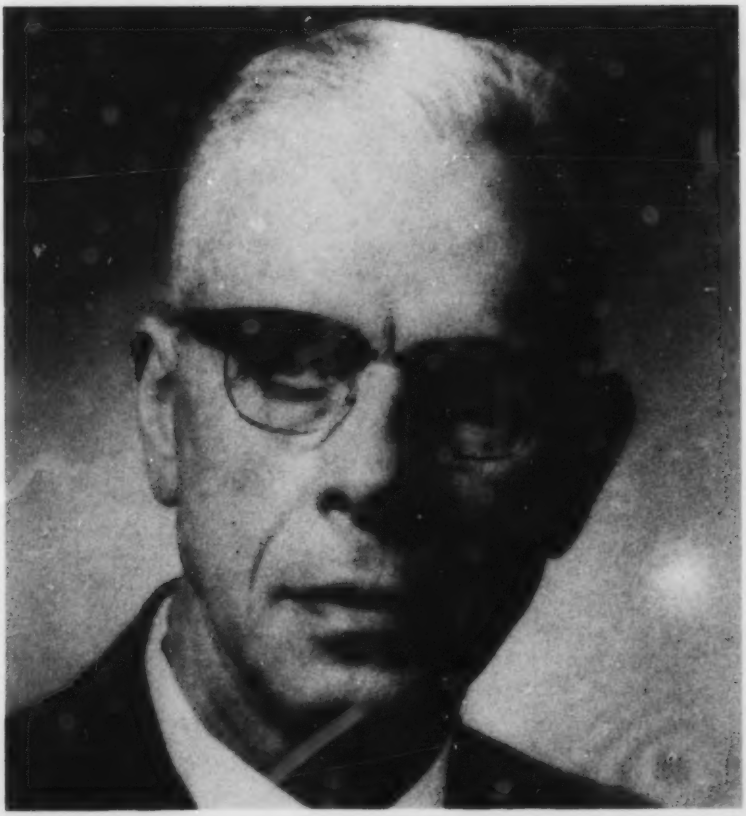
He was becoming more and more interested in manuscript illumination, and initiated, with G.S. Vickers, an ambitious project, the *Corpus of Illustrated French and English Bibles of the Twelfth and Thirteenth Centuries*. There followed active and productive years in the late fifties and sixties. The Briegers, settled with their sons Peter and Nicholas at 51 Woodlawn Ave. in town, and at the Mud House on the Massey estate near Port Hope, worked on the bible project; they dispensed hospitality to a host of friends and students, and travelled in the summers, visiting libraries throughout Europe to examine every known bible of the relevant period. The work was well advanced when he retired from active scholarship, but unfortunately he did not live to see its publication. He did, however, enunciate his theory regarding the revival of production of whole bibles in the late eleventh century. In a notable article of 1965 he suggested that the new emphasis on the Bible and its illustration was an aspect of church reform and of the campaign against the dualist heresies, which tended to reject the Old Testament.

Alongside the bible project, he was involved in other major scholarly undertaking in the sixties. There was a high-school textbook, written with two colleagues. Two lavish publications — *The Trinity Apocalypse* and *The Illuminated Manuscripts of the Divine Comedy* — were prepared during two terms at the Institute for Advanced Studies, Princeton, in 1960 and 1964. His last effort was the organization of the exhibition *Art and the Courts* for the National Gallery in Ottawa, and the writing of two essays for the catalogue.

He retired from full-time teaching in 1964, continuing on a part-time basis for three years. He then started a new career at the Pontifical Institute of Mediæval Studies until ill health forced his final retirement in 1973. It is as a teacher that he probably would have wished to be remembered. Fortunate former students use such phrases as "inspiring", "poetic", "eloquent", to describe his lectures. He could inspire in his listeners the sense of experiencing the work of art, particularly architecture, and imbued them with an appreciation for the seriousness of art and of the effort to understand it. After he died on 7 October 1983, the Department of Fine Art established a lecture series in his name which has attracted some of the leading members of the profession to Toronto to lecture in celebration of his memory.

LEWIS E. LLOYD

Earle Wilcox Crampton
1895 - 1983



TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

An American by birth, EARLE WILCOX CRAMPTON came to Canada in 1922, where he remained until his return to the U.S.A. in 1973. His reason for coming to Canada was to take up an appointment as Lecturer in the Department of Animal Husbandry in McGill University's Faculty of Agriculture at Macdonald College. He remained associated with that institution for a period of 51 years.

Earle Wilcox Crampton was born in Middletown, Connecticut, on 15 August 1895. He received a B.S. degree from the University of Connecticut in 1920, an M.S. from Iowa State University in 1922, and a Ph.D. from Cornell University in 1937. In 1960, he was awarded the D.Sc. (*honoris causa*) degree by the University of Reading. Following a lengthy illness, Dr. Crampton died on 20 April 1983, in the city of his birth.

During the early years at Macdonald College, Dr. Crampton's activities were increasingly directed towards teaching and research in nutrition. He was responsible for the formation of a Department of Nutrition in 1941; he become its first Chair, and subsequently the first Professor of Nutrition at McGill University. He was appointed Emeritus Professor of Nutrition in 1965, and maintained a close association with the Faculty of Agriculture until his return to the U.S.A.

The nutrition research program at Macdonald College was under Dr. Crampton's direction from its inception in 1925 until his retirement from administrative responsibilities in 1960. This program covered a wide field of interest in all species of farm animals, and from the mid-1940s included human nutrition studies as well. During this 35-year period the science of nutrition gained a level of respectability it had not held previously in the University, and Professor Crampton's Department of Nutrition gained an international reputation for its innovative nutrition research. He personally directed the research programs of some 70 students, contributed more than 100 publications to the scientific literature, and wrote or co-authored two textbooks on nutrition.

Much of Dr. Crampton's early research was devoted to the nutrition and feeding of market pigs. This included studies on the nutritional requirements of bacon-type pigs, the utilization of various Canadian feed grains and their milling by-products for pigs, and the nutritional requirements of early weaned pigs.

In the area of ruminant nutrition, Dr. Crampton carried out pioneer work with Dr. L.A. Maynard of Cornell University on the relation of cellulose and lignin content to the nutritive value of animal feeds. Some twenty years after this work, Dr. Crampton introduced new concepts relating to forage utilization of ruminants, and in particular the measurement of voluntary intake as a criterion of forage nutritive value — concepts that were to have worldwide influence on ruminant research for the next decade.

Dr. Crampton's interest in human nutrition was stimulated during World War II by requests from the Canadian government to become involved in research contracts that had to do with solving specific nutrition problems of that era. The following are representative of the human-related projects

undertaken during the 1940s and early 1950s: factors affecting the nutritive value of edible fats and oils, bioassay procedures for determining the vitamin C content of foods, effect of storage on the vitamin A content of mixed rations, and nutritive value of wheat fed in different forms.

Mention must be made of Dr. Crampton's contribution to nutrition at the national and international levels. Space does not allow for a description of his specific contributions in each of these areas. However, it should be noted that he 1) had long service on the Committee on Animal Nutrition of the National Research Council (NRC) of Canada; 2) was an active member of the Canadian Council on Nutrition from 1946 to 1963, where his greatest effort was exerted in the preparation of the first Dietary Standard for Canada; 3) served for over twenty-five as a member of the US-NRC Committee on Animal Nutrition, and also as a member of the first Sub-committee on Swine Nutrition; 4) working with his colleague, Dr. L.E. Harris of Utah State University, was responsible for the revised edition of the Joint United States-Canada Tables of Feed Composition and later the development of the International Network of Feed Information Centres.

Dr. Crampton was a Fellow of The Royal Society of Canada, the Chemical Institute of Canada, the Agricultural Institute of Canada, the American Society of Animal Science and the American Institute of Nutrition. He served on the Editorial Board of the *Journal of Nutrition* from 1947 to 1956, and as President of the American Society of Animal Science (1950) and of the Nutrition Society of Canada (1959). Dr. Crampton received the American Feed Manufacturers Award for research in animal nutrition in 1948, the Morrison Award for research in animal production in 1955, and the E.W. McHenry Award for distinguished service in nutrition in 1974.

In recognition of Earle Crampton's long and distinguished service to the Faculty of Agriculture of McGill University and of his outstanding contributions to the development of nutrition, in Canada as well as throughout the world, the nutrition laboratories at Macdonald College were formally designated the Crampton Nutrition Laboratory in 1973. In the same year, the Earle W. Crampton Award for Distinguished Service in Nutrition was established by McGill University.

All of those who were associated with Dr. Crampton during his long professional career will remember him as a teacher with high expectations of his students, as a scientist whose capacities seemed unlimited, and as a man completely dedicated to his profession. His tolerance was low for those who did not live up to their true capabilities, but there was no greater supporter than he for anyone who was prepared to exert maximum effort. Admiration and, above all, respect are two key words that will always be associated with the name of Earle Wilcox Crampton. The discipline of nutrition has been enriched by his lifetime of dedicated effort.

JEAN-PAUL VINAY, C.M., m.s.r.c.

Jean Darbelnet
1904 - 1990

MÉMOIRES DE LA SOCIÉTÉ ROYALE DU CANADA / SÉRIE VI / TOME I / 1990

JEAN DARBELNET est né à Paris en 1904. Il commença ses études au Lycée Carnot et les termina à la Sorbonne. Avant de s'inscrire à l'université, il hésita entre l'histoire et l'anglais, «deux matières pour lesquelles [il avait montré] le plus de goût». L'attrait des voyages et des séjours à l'étranger le décida en faveur de l'anglais; il commença une formation d'angliciste, «mot peu utilisé et même peu connu au Québec, qui s'applique dans la terminologie universitaire française à quiconque se spécialise en anglais». Il passa ainsi plusieurs années en Grande-Bretagne, à titre de lecteur dans les universités du Pays de Galles (Swansea), d'Edimbourg et de Manchester. À cette dernière occasion, il travailla avec la célèbre équipe des professeurs Kastner et Marks, qui venaient de publier leurs manuels sur la traduction de l'anglais au français. Il fut chargé d'en rédiger les corrigés, sous la direction des auteurs. Ce furent là ses premières publications : *Key to Passages for Translation into French*, trois volumes parus chez Dent, à Londres (1934-1937). Cette recherche de la perfection dans la langue d'arrivée, à partir de textes littéraires, devait être le principal souci de sa vie scientifique.

Tout en se familiarisant sur place avec la langue parlée et avec une culture très différente et originale, Jean Darbelnet continuait ses études universitaires. Il fut reçu au difficile concours de l'agrégation de l'Université de France en 1929. Ce titre lui ouvrait désormais les portes de l'enseignement officiel : il fut nommé successivement professeur d'anglais aux Lycées de Brest et du Havre, puis au Lycée Condorcet à Paris (1931-1937).

Sa carrière universitaire en Amérique du Nord débuta à Harvard (1938-1939). Il donna également des cours de traduction à la session d'été de Middlebury College. Nommé juste avant la guerre professeur de langue et littérature françaises à l'Université McGill, et directeur du département, il fut retenu en France au début des hostilités et ne put prendre son poste qu'en septembre 1940. Ce fut pour lui l'occasion de choisir la voie dans laquelle il allait de spécialiser.

On avait alors, traditionnellement, le choix entre deux démarches : «l'histoire et la critique de la littérature, voie dans laquelle s'engageaient la plupart des jeunes anglicistes candidats à l'enseignement supérieur — et la philologie ou histoire de la langue. L'engouement pour une linguistique descriptive et appliquée n'était encore le fait que de chercheurs solitaires et peu considérés». Jean Darbelnet, sans l'avoir choisie explicitement, se laissa entraîner dans une troisième voie, qui comportait «l'étude de l'anglais moderne en tant qu'instrument d'expression écrite et orale». Comme son enseignement l'amenait à considérer l'anglais dans son rapprochement avec le français, il se tourna vers une étude comparative des moyens d'expression dans les deux langues, à la suite d'un linguiste génevois, Charles Bally, créateur de la stylistique française. Il posait ainsi les bases d'une stylistique comparée, qu'il devait élargir par la suite en créant une nouvelle démarche, celle de la linguistique différentielle.

Lorsque la Société des Traducteurs de Montréal voulut offrir à ses membres un moyen d'améliorer leur connaissance des deux langues, le Directeur des cours d'extension de McGill demanda à Jean Darbelnet de se charger de

l'enseignement de la traduction, le mettant ainsi en contact avec un public adulte, en majorité francophone, qui sentait le besoin de se spécialiser dans ce domaine.

Il reprit le chemin des États-Unis en 1946, comme professeur de langue et littérature françaises à Bowdoin College (Brunswick, Maine), où il devait rester jusqu'en 1962. Son séjour à Montréal lui avait permis d'étudier le comportement linguistique d'une population francophone en contact permanent avec l'anglais. Il observait chez ses élèves à la fois un comportement différent vis-à-vis du français de France, et une contamination certaine de leur langue par suite de leur bilinguisme. Sans vouloir pour autant imposer systématiquement une norme parfois difficile à préciser, Jean Darbelnet s'intéressa dès lors aux problèmes langagiers qui préoccupent un Canada bilingue. De 1957 à 1962, il rédigea une chronique bimensuelle sur le français contemporain intitulée «La langue et la vie», pour la revue montréalaise *Notre Temps*. Une grande partie de ces rubriques fut publiée en 1963 dans un volume intitulé *Regards sur le français actuel*. Il perfectionnait ainsi une méthode d'observations des faits de langue, de leur notation, de leur rapprochement avec des faits anglais comparables, en dehors de toute théorie «ce qui ne m'empêche pas, dit-il, de m'élever ensuite à des notions théoriques — et je préfère parler de notions, au pluriel, plutôt que de théorie au singulier. Je me préoccupe surtout de recuillir des faits de langue dans les deux domaines que je continue à observer avec un égal intérêt. Comme les deux langues se renouvellent constamment, je ne risque pas de manquer de matière et je ne m'ennuie jamais.»

Par un heureux concours de circonstances, nous nous sommes rencontrés à Montréal en 1946, chacun apportant ses observations personnelles à un échange d'idées sur la traduction, à une réflexion sur les modes de passage d'une langue à l'autre. Cette collaboration n'était pas entièrement le fruit du hasard. Par le choix d'une même carrière, nous avions suivi des voies parallèles qui nous avaient menés dans les mêmes lieux académiques, et poussés à faire des travaux dans le même sens. Après quelques années de maturation et une fois réuni un corpus suffisant d'exemples, nous pûmes mettre sur pied la *Stylistique comparée du français et de l'anglais* (Paris, Montréal, 1958-1977) qui a permis de jeter les bases d'un enseignement objectif de la traduction. «[Cet ouvrage] constitue en ce qui concerne les deux auteurs la réalisation le plus importante de leurs publications.» Je me dois d'ajouter que si ce manuel a pu servir de base de travail à de nombreux étudiants, c'est en grande partie grâce au talent de Jean Darbelnet, dont l'esprit logique et précis informait admirablement le déroulement de notre démarche.

Nommé en 1962 à l'Université Laval, Jean Darbelnet y enseigna la grammaire du français moderne, la traduction, la stylistique comparée et la linguistique différentielle, jusqu'en 1975. Il fut appelé dès lors à jouer un rôle de conseiller et de guide en matière de langue, à une époque où le Québec passait précisément aux réalisations pratiques de son programme linguistique. Il fut nommé successivement membre du Conseil international de la langue française (Paris, 1968), membre du Conseil canadien de recherches sur les

humanités (1966-1970), membre du Comité consultatif de l'Office (devenu Régie) de la langue française (Québec, 1963-1974) et consultant auprès du Bureau des traductions (Ottawa). Ses préoccupations langagières se traduisent par plusieurs ouvrages didactiques : *Words in Context* (1973) écrit en collaboration avec G. Vitale, *Le français en contact avec l'anglais en Amérique du Nord* (Québec, 1976), *Pensée et Structure* (New York, 1969-1977), *Le français au bureau*, 2e édition (1982) et un très utile *Dictionnaire des particularités de l'usage*, publié par l'Université du Québec en 1986.

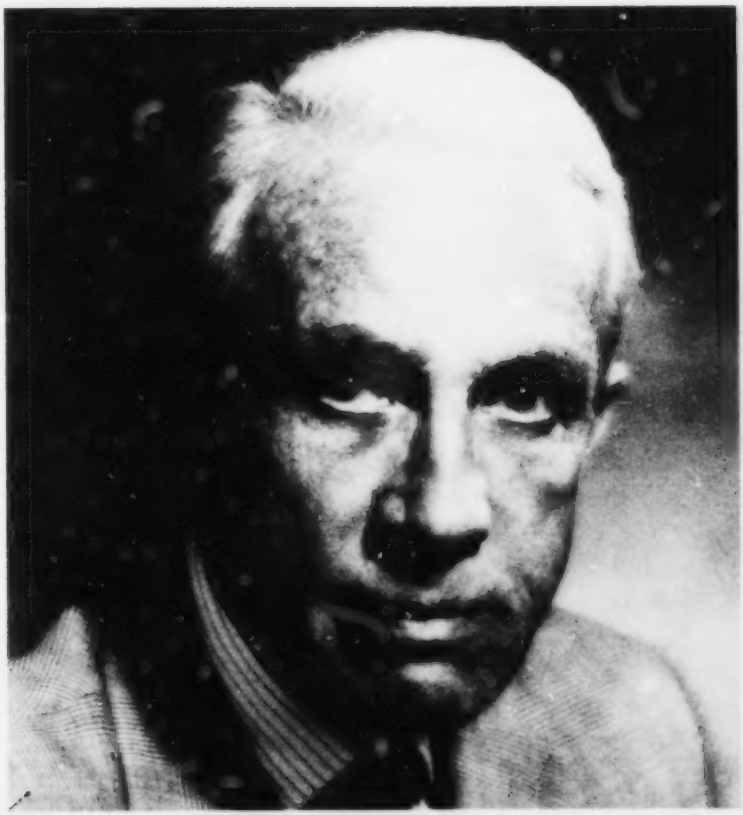
Une bibliographie presque complète des œuvres de Jean Darbelnet a été publiée dans un livre d'Hommage intitulé *Le français en contact avec l'anglais* (Paris, 1987). Cette liste ne comprend pas moins de 101 titres, dont 78 articles et 15 textes parus à diverses occasions dans des collectifs. Les sujets traités intéressent principalement la sémantique différentielle, le rôle et la responsabilité des traducteurs, le dépistage des anglicismes, les emprunts et les néologismes, la Francophonie et la norme lexicale au Québec. Il y a là un véritable trésor de doctrine langagière, toujours précise, nourrie d'exemples, jamais exclusive ou pédante, qui mériterait d'être publié en un seul volume. On y verrait ainsi la continuité de l'effort critique, la précision de la pensée, le fini d'une technique descriptive servie par une incomparable connaissance des deux langues.

Jean Darbelnet est décédé à Québec en 1990, laissant deux enfants, Anne et Robert, et trois petits-enfants. Il avait perdu sa femme, née Elizabeth Matheson, elle-même spécialiste de français, en 1982. Il fut nommé membre de la Société royale du Canada en 1969, et présenté à l'Académie I par René de Chantal; il joua un rôle actif dans la rédaction française des règlements de notre Société. Rappelons qu'il fut professeur invité à Middlebury College (1938-1939), à UBC (1957 et 1961), à University of Alberta (1959), à l'Université Laval (1960), à l'Université de Montréal (1964-1965), à University of Toronto (1969) et à l'Université d'Ottawa (1977 et 1979). Il était membre de la Modern Language Association of America, de l'Association canadienne de linguistique qu'il présida de 1966 à 1968, de la Société des écrivains canadiens et de la Société des Gens de Lettres de France. La Société des traducteurs du Québec l'avait élu membre d'honneur et l'Université d'Ottawa lui avait décerné un Doctorat *Honoris causa*. Officier d'Académie et Chevalier de l'Ordre national du Mérite (France), il était professeur émérite de l'Université Laval.(*)

* Les citations utilisées dans le présent article proviennent d'une notice bibliographique rédigée par lui-même et présentée à la Société des Ecrivains canadiens en 1982. Cette notice est restée inédite. *JPV*

FRANCESS G. HALPENNY, C.C., F.R.S.C.

H. Lovat Dickson
1902-1987



TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

HORATIO HENRY LOVAT DICKSON (he was always called "Rache"), editor, publisher, writer, was born on 30 June 1902, in Victoria, Australia. His paternal family had a long Canadian history. Originally Scotch-Irish and always Presbyterian, his ancestors had gone to Connecticut and moved to Nova Scotia after the British had taken the colony. There they became shipbuilders and shipowners of consequence, and travellers of the seas. It was Lovat Dickson's grandfather who went to Australia, as a shipping agent for British companies. His father was a mining engineer, and the family followed him into the up-countries of Australia and Rhodesia. It was a close-knit family. Rache was devoted to his charming, beautiful, and energetic mother. His father, colourful and extravagant, read aloud to his sons the books he liked to read himself, Dickens and Thackeray especially, Trollope, Haliburton's Sam Slick, and the English poets. He laid the foundation for Lovat Dickson's fascination with words and the rhythms of writing. Reading was also part of the building up of a deep feeling for Britain shared with his ancestors: "We were a Colonial family, and were proud of it. We passionately believed in the British Empire, and especially in England."

England he came to as a boy of 11, in 1913. Professional reverses had sent his father there, and were to take him after a few years to a post at the Royal Mint in Ottawa. Rache's mother became gravely ill with cancer, and in 1917, at the height of the submarine attacks, the family travelled to join the father. Mrs. Dickson lived only three weeks more. Her death was a desolation for her oldest son, and it broke up the family. Lovat Dickson, at 15, confronted by the poverty of their situation, considered his haphazard schooling over. He moved through a succession of "dreary, uncongenial" low-paying jobs — on farms, in offices, on a shipyard — with a brief interlude as a cadet officer in the RAF (under age). It was his habit of reading and his continued efforts at literary composition that often provided solace for his frustration about getting on and his personal loneliness as a young man. His father had gone to mining operations in the west and Lovat Dickson eventually joined him. Starting with his first railway journey across the northern vastness, Dickson was to gather a lasting impression of its "immense, brooding solitude", as he had earlier of the majesty of the St. Lawrence and the Laurentians. Physical labour in mines turned out badly, however. He fortunately escaped to the University of Alberta and there "on the bluffs above the swift-flowing North Saskatchewan River" his life began again. In this still-new university the dominant influence upon him was E.K. Broadus (whom he then and later called "The Professor"), a figure legendary for his sharp tongue and rigorous standards but also for the inspiration of his teaching of English. Dickson thrived on the inspiration and the hard reading, helping with his fees by writing articles for the *Edmonton Journal*. He graduated B.A. 1927, M.A. 1929, with distinction, and was lecturer in English 1927-29. A promising academic career lay ahead, when "an extraordinary chance" intervened. A wealthy Alberta businessman with a literary bent and a habit of residence abroad offered him a position as assistant editor to him on an English review he had purchased. To Broadus' anger, Dickson resigned from Alberta.

In 1929 Lovat Dickson came to London, a city in which he felt a "place" as a Canadian and as a dedicated reader of English literature but in which he, an inexperienced new editor, had to make his way in a forum of distinguished weekly, monthly, quarterly periodicals and of publishing houses, long established or newly set up, with their associated literary agents and literary clubs. He also wanted to write, and London "was the only place where a man could be in the literary world". As associate editor of the *Fortnightly Review* 1929-32 (the businessman editor stayed abroad), Dickson received editorial advice and friendship from a growing number of literary people and his editorship was a success though the days of these great periodicals, which had discussed all the issues of the times, were numbered and subscriptions were harder to come by. He also edited the *Review of Reviews* 1931-34. His own interest shifted to books, however, impelled a good deal in that direction by his experience as agent for the Macmillan Company, U.S.A., in finding British books for their list. He decided in 1932 to take the considerable risk of establishing Lovat Dickson Limited, his own publishing firm of which he was, formally, Managing Director. For the next six years he enjoyed all the challenges, pleasures, and perils of a good publisher, with the right instincts for manuscripts, but a publisher without adequate working capital to sustain and expand his business.

To give more visibility to his imprint he started *Lovat Dickson's Magazine* in 1933. In 1934 he married Marguerite Brodie, a Canadian. On his list appeared four hundred books by 1938 with valuable names, ranging from Mary Poppins, Lloyd Douglas, Eiluned Lewis to Jules Romains. And of course Grey Owl. He introduced himself in a letter from a log cabin in northwestern Saskatchewan, and the manuscript Lovat Dickson published in 1935 was *Pilgrims of the Wild*. It was an immediate success. Dickson also arranged a lecture tour for him in Britain in 1936-37 which had full houses of enthusiastic people enthralled by Grey Owl's gifts as a story-teller and his feeling for the woods and the beaver. A children's book, *The Adventures of Sajo and Her Beaver People*, was published in 1935 and *Tales of an Empty Cabin* in 1936. Another successful tour was arranged for Britain by Dickson in 1937-38; it culminated in a private presentation by Grey Owl for the Royal Family. The tours had not been easy to manage, given the problem with Grey Owl of alcohol and erratic temperament, but they had given an important message of respect for wildlife. Grey Owl died in 1938, and at once the story of his true identity as Archie Belaney broke. Dickson was deeply disturbed that this author to whom he had given fame and friendship had not confided in him and by the popular press's playing up of the story as one of deceit and hoax without giving credit for what Grey Owl had done in and for the wilderness. Dickson thought there might be mistaken identity, but soon, especially after meeting the Belaney aunts in England, accepted the reality. In 1939 he wrote a somewhat defensive account *Half-Breed: The Story of Grey Owl*. The man was to continue in his thoughts for years.

Grey Owl's success contributed greatly to the finances of Lovat Dickson, Limited. But the financial problems remained, and in 1938 Dickson sold his list to Peter Davies and joined Macmillan and Company as assistant editor of

general books, working under Harold Macmillan. He became chief editor, then a director of the firm from 1941 to 1964. The years of the war were not easy for publishers, with the dislocations of bombing and with the scarcity of paper meaning that back-list books had to go out of print; yet the need of people under stress for reading was great. After the war rebuilding was slow, and the post-war conditions of society very different.

In one period of introspection during the war, when he needed the help of writing, Dickson wrote a novel drawing on his Alberta years, *Out of the West Land*, published in 1944 to modest success in England and Canada. His *Richard Hillary* (1950) was a biography of an RAF war hero whose memoir he had published. The titles Dickson brought to the Macmillan list included many of distinction, and his service to the firm was noteworthy. His other activities were to include establishing St. Martin's Press in New York on behalf of Macmillan, and being a founding director of the Reprint Society and Pan Books; he served on the Canadian Committee of the British Publishers' Association.

Before his retirement from publishing Dickson took stock of himself, of publishing, of writing in two volumes of autobiography. *The Ante-Room* (1959) deals with the years up to his leaving for London in 1929 and *The House of Words* (1963) with his publishing and literary life there. They were reprinted in 1975 and 1976 respectively. *The House of Words* is eloquent of literary London, of publishers and authors. It remains an engrossing personal and group story and a revealing analysis of what being a publisher means, about the qualities of endless curiosity and of instinct leading to judgment about manuscripts, about the creativity that lies at the very heart of this profession.

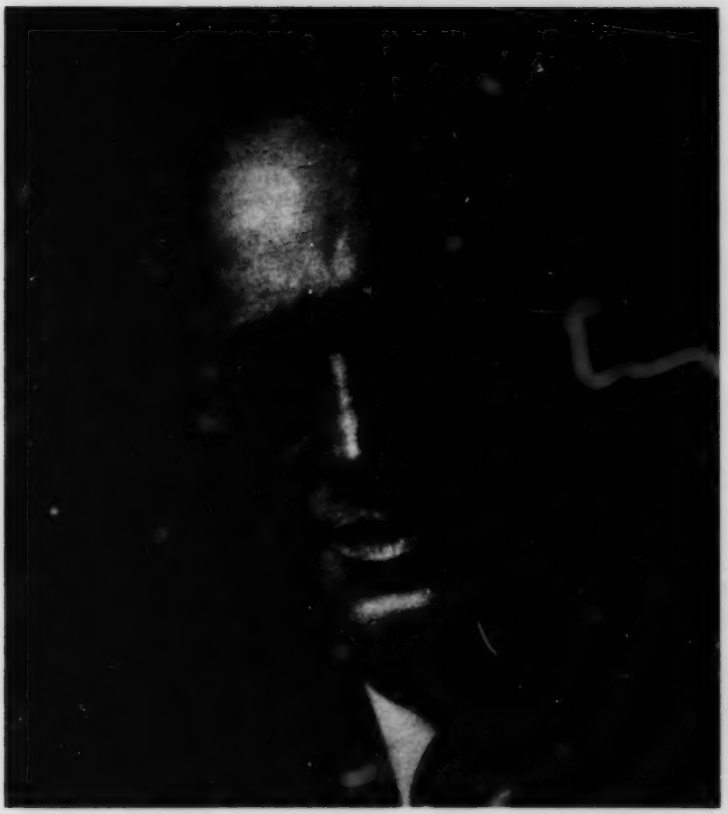
In 1967 Lovat Dickson came back to Canada with his family, and maintained an active career as a writer in Toronto. In 1969 he published a study of a major author he had known, *H.G. Wells: His Turbulent Life and Times* (reprinted 1971), and in 1975 another he had been asked to undertake, *Radclyffe Hall and the Well of Loneliness: A Sapphic Chronicle*. In 1973 he had come back to Grey Owl, still present with him "in a strong outflow of memory", one who had sent his life "spinning through a period of action and high drama". This time the story, *Wilderness Man* (still available in paperback), told with a writer's gift for scene and character, was more objective and more studied, based on fuller evidence. Dickson acknowledged the help of Donald B. Smith, then embarking on his years of research into Indian-white relations (Smith's presentation of detailed evidence was finally published in 1990 as *From the Land of Shadows: The Making of Grey Owl*). As one re-reads Dickson's books one has a strong impression of how his preoccupation with Grey Owl was something more than interest in a colourful author and in a mystery: there was a peculiar link with this man, unlike him in so many ways, but like him in having pulled himself out of an earlier life that might have drawn him permanently down and doing it by finding a mission through the power of words and the imagination. Then too Grey Owl always wrote of the Canadian wilderness, that "land of shadows" and intense silence; Dickson carried his memory of Canada and of its vast distances into the London he

came to understand intimately but of which he knew he was not and never could be a "tribal" part.

In Toronto Dickson's active life included the preparation of scripts for television, including one on the Massey family. He lectured on publishing at York University, participated in the Writers' Union, the Arts and Letters Club, the Victorian Studies Association, and was on the executive of the Friends of the Osborne Collection. His last book was a commissioned history of the Royal Ontario Museum, *The Museum Makers* (1986), in which his flair for story enabled him to surmount at many points the aridity of institutional manœuvres. Honours accumulated: 1968, LL.D. University of Alberta; 1973, D. Litt. The University of Western Ontario; 1978, Officer, Order of Canada; 1981, D. Litt. York University; 1982, F.R.S.C. Lovat Dickson was truly a "man of letters" in the traditional sense, and to the phrase he added his own particular grace.

IAN PARKER

William Thomas Easterbrook 1907-1985



TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

WILLIAM THOMAS EASTERBROOK was born on 4 December 1907 in Winnipeg, Manitoba, where he was raised and obtained his early education. Both his Winnipeg origins and the times in which his early years were spent exerted a powerful influence on the course of his personal and intellectual development, and help to account for his subsequent major contributions to the study of North American economic history and the analysis of long-period political-economic change.

Winnipeg has historically occupied a peculiar position in the Canadian political economy, as both a centre of commerce and industry, relative to its prairie hinterland, and a margin, relative to the principal eastern Canadian centres of power, influence and finance. The formative years of Easterbrook's development were marked by the effects of the First World War, the 1917 Winnipeg General Strike, and the onset of the Great Depression in 1929. His birthplace alerted him to the importance of interaction between economic centres and margins in the determination of patterns of historical change; the times in which he matured impressed upon him the central role of uncertainty in economic history.

In contrast to the continuous educational path followed by many fellows, Tom Easterbrook did not receive his honours B.A. degree in English and economics from the University of Manitoba until 1933, in his twenty-sixth year. Prior to receiving his undergraduate degree, Easterbrook had already worked full-time for a bank, in the worst stage of the Great Depression, and in fact his completion of his degree was enabled by a bank scholarship.

Following the completion of his B.A. degree and a short period working for the bank, Easterbrook began his graduate studies in the newly formed political economy doctoral program of the University of Toronto, under the supervision of Harold Innis. He was the recipient of the first Canadian doctorate awarded in economics for the thesis published in 1938 as *Farm Credit in Canada*. The title of the work, which remains one of a handful of classics in the economic history of Canadian banking and finances, gives an inadequate sense of its scope.

The core of the work focused on the policies followed by the chartered banks and the provincial and federal governments to address the problems faced by Canadian agriculture in the Depression. Yet the study began with an extended historical overview of the Canadian banking system that documented the persistent historical failure of the system to channel adequate resources into agricultural, industrial and infrastructural development, thereby necessitating a more active entrepreneurial role on the part of the Canadian state, a role accentuated by the Depression.

Easterbrook taught at the University of Toronto during the 1937-38 term, and on 28 December 1937, he and his wife Dorothy were married. They then moved back to Manitoba, where Easterbrook taught at Brandon College, in the University of Manitoba system, for about a decade. In 1947, he returned to the University of Toronto, where he remained until his death. He rose through the ranks until he was made a full professor in 1956, coincidental with his tenure as Pitt Professor of American History and Institutions and Marshall

Lecturer at Cambridge University, and the publication of his and Hugh Aitken's basic text, *Canadian Economic History*.

This textbook had a remarkable record of longevity. Revised only once, in 1963, it dominated the field of Canadian economic history for over three decades, notwithstanding the considerable progress of research in the field after its initial publication. Its sustained success was due in part to the comprehensiveness of its scope, which included discussions of the historical development of the principal European powers involved in the exploration and settlement of North America, and of the United States and Mexico; in part to the accuracy and robustness of its detailed analysis; and perhaps most significantly, to the power of its informing vision, which focused on the entrepreneurial response by public and private agents to the political and economic uncertainties confronted in Canadian historical development.

During the period from the late 1940s to 1963, Easterbrook published a series of articles on the themes of bureaucracy, enterprise and uncertainty in long-period economic change, and produced a manuscript entitled "Climate of Enterprise", which he unfortunately ultimately decided not to publish. The manuscript, available in the Easterbrook papers of the University of Toronto Archives, is a profound study of the roles of bureaucratic and enterprise forms of entrepreneurship in long-period economic development, which contains some brilliant reflections on issues such as the role of warfare in economic development and the secular increase in the average scale of economic activity since the mediaeval period. Easterbrook's perfectionist impulses may in this instance have cost scholarship a major contribution. Yet during this period, with Mel Watkins as co-editor, he also compiled *Approaches to Canadian Economic History*, which has since become a staple of courses in Canadian history.

There are likely three major factors that account for Easterbrook's decision not to publish "Climate of Enterprise" (despite his mentor Innis's encouragement, before Innis's death in 1952, to do so). The first stems from Easterbrook's decision to write *Canadian Economic History* (with Hugh Aitken) before completing "Climate of Enterprise". The second relates to his decision to accept the position of Chair of Political Economy at Toronto from July 1961 to June 1969, during a period of unprecedented growth for the Department. The administrative demands on his time and energies during the decade cut seriously into his time for scholarly production, and inhibited his ability to eliminate what he regarded as the limits of the manuscript. The third factor is perhaps most significant. Easterbrook came to believe that the analytical framework that informed the "Climate of Enterprise" manuscript was inadequate for the long-period study of entrepreneurship in history, insofar as it was excessively biased towards a concern with the preconditions for small-scale private "enterprise", and did not give adequate attention to the uncertainty environments in which large-scale "bureaucratic" entities (governments, churches, and corporation) became the principal agents of entrepreneurial activity.

Easterbrook's final major work, *North American Patterns of Growth and Development* was published posthumously in 1990, but for all practical intents and purposes, Easterbrook had completed it shortly before his death in 1985. The work was the culmination of a lifetime of study of the determinants and patterns of long-period economic-historical change, couched in the form of a comparative analysis of the development paths of Canada, the United States, and Mexico from the earliest stages of European exploration and colonization to the twentieth century. Designed on a broad spatial and temporal scale, the volume is informed by the battery of conceptual tools Easterbrook had developed and refined over more than three and a half decades, in articles, lectures and seminars.

His generalized concept of entrepreneurship; his focus on the entrepreneurial response to uncertainty, and on uncertainty environments that enabled decentralized, "enterprise" forms of entrepreneurship in some historical contexts and necessitated centralized, " bureaucratic" forms in others; his subtle and wide-ranging analysis of the different forms of centre-margin interaction; his emphasis on the formation of "security zones" as an essential prerequisite of risk-taking and innovation; his distinction between patterns of "persistence", or growth, and patterns of "transformation" which generated structural change or development: these and other conceptual innovations provided him with a powerful basis for his original reinterpretation of the divergent patterns of growth and development in North America's four major regions, Canada, the Northern United States, the Southern United States, and Mexico.

Written under adverse circumstances, in the face of his wife's death and his own serious medical difficulties, which often involved extended stays in hospital and lengthy periods of recuperation, *North American Patterns* was a tribute to his tenacity as well as to his profundity and vision.

Easterbrook inherited Harold Innis's mantle as the doyen of Canadian economic history, and like Innis and Easterbrook's undergraduate and lifelong friend, Marshall McLuhan, he possessed a genuinely original mind. More cautious than both of these colleagues at the University of Toronto, he nevertheless had the same gift that Innis and McLuhan possessed of being able to inspire students with a recognition of the complexity of historical processes, and to develop students' capacity for independent creative thought. His own conceptual development owes a considerable debt to Innis, as well as to economists like Schumpeter, G.L.S. Shackle, B.S. Keirstead, F.C. Lane and C. Goodrich. He extended and transformed what he drew from these influences, however, in creating his own distinctive heuristic framework for the comparative analysis of long-period historical change.

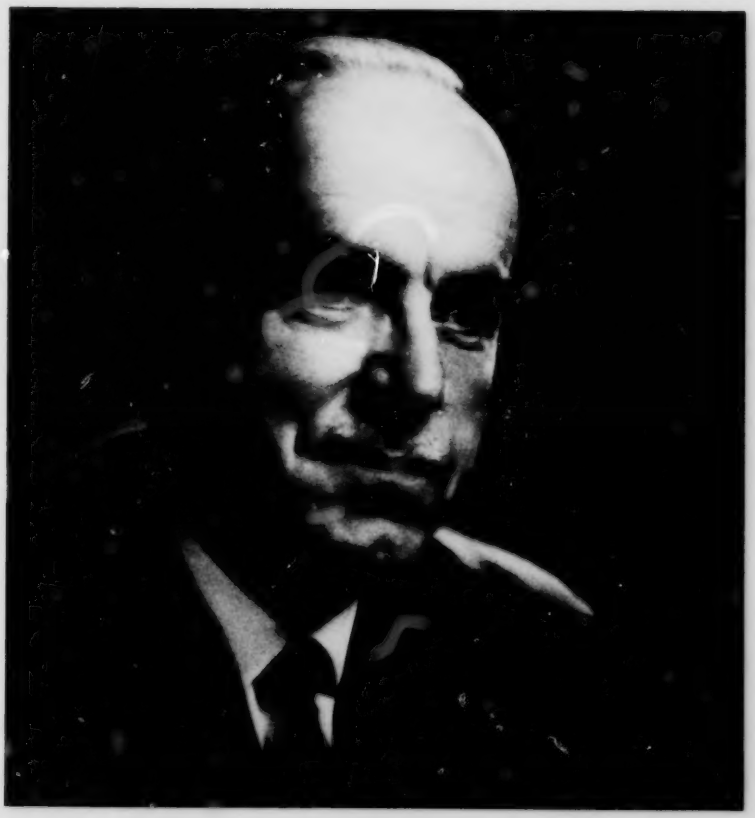
Tom Easterbrook's scholarly achievements were acknowledged by the Economic History Association, which he served as vice-president from 1958 to 1960; by the Business History Foundation, which he served as a trustee from 1959 to 1963; by his alma mater, the University of Manitoba, which awarded him an honourary doctorate; and by The Royal Society of Canada, of which he was made a Fellow. He also taught at the University of Cambridge in

1955-1956 and at the Australian National University in 1965, and served as an economic advisor to the governments of Tanzania (in 1966-67) and of Mexico (in 1971-72).

Yet for generations of students, Tom Easterbrook's greatest legacy may derive from his exceptional gifts as a teacher. His excitement over ideas, his generosity and consideration for the ideas of others, his dry sense of humour, sardonic without being cynical, his dissatisfaction with glib or easy answers, his consistent ability to open whole new perspectives and avenues of thought with a well-timed question or two, his powerful conceptual framework, and his vision of intellectual activity as a journey of exploration into deep and uncharted waters stirred and stimulated those who were fortunate enough to study with him. Many of his former students can say, without exaggeration, "It was Tom Easterbrook who taught me how to think for myself".

A.W. JACKSON

James Gibbard
1901-1987



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JAMES GIBBARD, past Director of the Laboratory Centre for Disease Control, Ottawa, and outstanding member of the Canadian Public Health community, died 13 September 1987 at the age of eighty-six.

Born in Toronto, he received his early education in that city obtaining the B.S.A. in Bacteriology from the University of Toronto in 1923. Further studies in bacteriology followed at the University of Chicago from which he received the S.M. degree in 1927.

After a short stint as Assistant Engineer in the Ontario Department of Health (1927-28) he joined the Department of Health, Canada, as a Bacteriologist in the Bacteriology Division of the then fledgling Laboratory of Hygiene. With a total staff of four and numerous responsibilities under The Food and Drugs Act, the newly appointed microbiologist became involved in a number of studies related to problems of the time. Among these studies was investigation of the sanitary qualities of shell-fish producing areas in the Maritime Provinces following an outbreak of typhoid in the U.S. found to be due to consumption of contaminated shell-fish. Somewhat later, paralytic shell-fish poisoning became an issue following fatal cases of poisoning in Nova Scotia in 1936. Mr. Gibbard was deeply involved in the development of methods of detection of shell-fish poisons and, in consultation with U.S. authorities, worked to establish mutually acceptable standards which would ensure the safety of shell-fish entering into trade between the two countries.

With his background in bacteriology he was called upon to develop test methods which would enable the Department to ensure the potency and effectiveness of vaccines and anti-sera offered to the medical profession in Canada.

During the ten-year period following his appointment to the Department, he was involved in a variety of activities associated with the role of the Laboratory of Hygiene in assuring the safety and efficacy of biological drugs and the quality of foods. This can be concluded from such appointments as Dominion Analyst under The Food and Drugs Act, Analyst under The Pest Control Act, Chemist-Bacteriologist and in 1938 Senior Bacteriologist. With the outbreak of war and the consequent marked increase in demands for laboratory services, Mr. Gibbard was promoted to Assistant to the Chief of the Laboratory of Hygiene. He was deeply involved in the new services which included standardizing tests for syphilis, a laboratory for evaluation of smallpox vaccine, and a service to evaluate penicillin being prepared in Canada to supply the needs of the Armed Forces.

In recognition of his knowledge of laboratory services and his qualities of leadership, Mr. Gibbard was appointed in 1948 to the position Director of the Laboratory of Hygiene. Under his direction the laboratory underwent rapid expansion in the number of services offered and in its personnel. Modern facilities were designed and constructed to house the enlarged Virus Section and following this the bacterial laboratories. The organization took on the characteristics of a modern public health laboratory.

A large contribution of the Director stemmed from his support of the Technical Advisory Committee on Public Health Laboratory Services com-

posed of the Directors of the Provincial Public Health Laboratories together with Senior Members of the Laboratory of Hygiene and having among its objectives coordinating the activities of the Provincial and Federal Laboratories and elimination of duplication of services, all aimed at ensuring the best use of resources. He served as Chair of this Committee during his tenure as Director of the Laboratory of Hygiene. A measure of the recognition received by the Laboratory under his direction may be seen in the number of requests received from various provinces for assistance in organizing their laboratory services in preparation for the introduction of National Health Insurance.

In 1962 he left the Directorship and was appointed consultant on Health Laboratory Services to The Federal Department of Health. Two years later he retired from the Federal Government to become a Field Consultant in Laboratory Organization and Planning to the World Health Organization. Assignments for the W.H.O. took Mr. Gibbard to Iraq, Pakistan, Taiwan and Malaysia. In addition he served for a period as acting director of Laboratory Services in Geneva at W.H.O. Laboratory Headquarters.

Following his retirement from the Civil Service, Mr. Gibbard took up residence in Smith Falls where for a number of years he was active in local politics with special interest in health services.

His knowledge of biological pharmaceuticals was widely recognized both nationally and internationally resulting in appointments to committees dealing with standardization of biological preparations. He was a member of the Expert Advisory Panel of Biological Standardization for the World Health Organization from 1953 to 1963. He was consultant to the British Pharmacopœial Committee and also to the Canadian Committee on Pharmacopœial Standards.

During his career he was active in a number of Canadian and American associations which reflected his professional interests. He was a member of the Association of American Immunologists; a member of the American Public Health Association, becoming Chair of the Laboratory Section in 1946 and Vice-President of the parent association in 1951; a member of the Conference of State and Provincial Laboratory Directors, elected Vice-Chair in 1948 and 1951 and Chair in 1959; a member of the Canadian Public Health Association, elected Chair of the Laboratory Section in 1950.

He was elected Fellow of the American Public Health Association and, in 1952, Fellow of The Royal Society of Canada. He is survived by his wife Helen, daughter C. Janet West, and son Dr. Bruce A. Gibbard.

JOHN F. GRAHAM, F.R.S.C.
and NITA GRAHAM

George Parkin Grant
1918-1988

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"Out of the shadows and imaginings and into the truth". These words that adorn the headstone on George Grant's grave epitomize the man and his life, a man whose pusuit of wisdom was driven by his love of the beautiful and good. His was a life that strove, in the words of Diotima, "to conceive and bear the things of the spirit... Wisdom and all her sister virtues;... [and] by far the most important kind of wisdom is that which governs the ordering of society and goes by the names of justice and moderation". All his life, his conversations, his writings were of virtue, "what human goodness is and how the virtuous should live".

GEORGE PARKIN GRANT was born in Toronto on 13 November 1918, the son of William Lawson Grant and Maude (née Parkin) Grant. His father, after a period in the History Department at Queen's University, became principal of Upper Canada College, as had been his maternal grandfather, Sir George Parkin. After his father's death in 1935, his mother, Maude Grant, became Warden of Royal Victoria College at McGill University. His grandfather, George Monro Grant, a Presbyterian clergyman, is credited with building Queen's University, as its long-time principal, into a leading Canadian institution.

After attending Upper Canada College, George Grant graduated from Queen's University with first class honours and the University Medal in history, in 1939. He won a Rhodes Scholarship to Oxford on which he began work towards a B.A. degree in jurisprudence at Balliol College. His studies were interrupted by World War II. A pacifist, he undertook assignments, first in charge of a section of the London docks during the worst period of air raids, and then as a merchant seaman on the Atlantic. At that time, he contracted tuberculosis. Following a period of convalescence, he worked on a farm in England. It was then that he experienced his sudden and remarkable conversion to Christianity, as he put it, "the affirmation that beyond time and space there is order ... that ultimately the world is not a maniacal chaos".

After a short period as Secretary to the Canadian Association for Adult Education, 1944-45, he returned to Oxford, 1945-47, and changed course to work for a doctorate in philosophy of religion, obtaining his D.Phil. degree in 1950. It was there that he met and married Sheila Allen, to begin a marriage that, as Senator Richard Doyle in his tribute to George Grant in the Senate put it, "began a partnership that ornamented the institution of matrimony".

From 1947 to 1960, as George Munro Professor of Philosophy and head of the Philosophy Department at Dalhousie University, he entered into the teaching and study and exposition of philosophy that came to establish his position as Canada's leading political philosopher in illuminating and explicating what it means to live in the modern world. His first major work, *Philosophy in a Mass Age*, initially delivered as a radio series for the CBC, was published in 1959. This was to be but the first of a number of radio talks in which he engaged the attention of countless listeners with his examination and clear presentation of central philosophical questions.

In 1960, he returned to Toronto to build a Department of Philosophy at the newly established York University. In its beginning, York was under the tutelage of the University of Toronto. When Grant learned that he would have to use a texbook that was completely unacceptable to him, he resigned. Philosophy, for Grant, was not something to be taught from a textbook — any textbook. In the classroom, it was a mutual exploration of what great men and women have conceived goodness to be. It could not be systematized to be transmitted as a body of facts as might be the case in an empirical science. His resignation was a singular act of courage for him and his wife, with a family of six young children and no alternative means of support. At the invitation of Mortimer Adler, he spent the year as consultant to the Institute of Philosophical Research at San Francisco.

In 1961, he joined the Department of Religion at McMaster University, where he remained until 1980, when he returned to Nova Scotia and to Dalhousie as Professor in the Departments of Classics, Political Science and Religion. He retired in Halifax in 1984.

His published works consist of numerous articles and several books, works not addressed simply to other philosophers, but accessible in lucid language to a broad public. He was frequently a speaker at rallies opposing the war in Vietnam. In later years, together with Sheila Grant, he wrote against absolute free choice in the matter of abortion.

His well-known *Lament for a Nation: The Defeat of Canadian Nationalism* (1965), a book written to show how Canada under Liberal governments had irrevocably surrendered its independence as a nation to the American empire, paradoxically roused a generation of young Canadians to try to define and defend Canadian nationalism. A French translation of *Lament for a Nation*, *Est-ce la fin du Canada?*, was published in 1987.

Why the defeat of Canadian nationalism is lamentable is indirectly drawn out in *Technology and Empire* (1968). The technological drive to the universal homogeneous state can only result in tyranny. In 1971 appeared *Time as History*, based on the 1969 CBC Massey Lectures, which is an analysis and elucidation of Nietzsche's historicism and the meaning of the loss of the sense of the eternal. *English Speaking Justice* (1986) is a brilliant critique of John Rawls's theory of justice and an examination of the meaning of justice in a contractual society, and of how this modern account of justice fails in determining the ends of modern technological power. That this technological imperative towards the conquest of nature, at the heart of modern science, has determined "what we think justice to be" is explored in *Technology and Justice* (1986).

Grant saw his task as a political philosopher to understand and elucidate such questions in order to understand the Western World, whatever the conclusions. He believed that, when examining another philosopher, one must "confront" that philosopher, that is, one must try to comprehend fully and face up to all that is both there and not there. This is the unrelenting task to which he applied himself, whether addressing the works of Plato, Rousseau, Nietzsche, Heidegger, Weil, or the work of a great artist such as Céline.

George Grant's teaching and writing revealed a profound understanding of modernity: of the darkness and nihilism that ensue from a surrender to the view of freedom that there are no limits to what can be done to nature, including human nature, combined with the ever-burgeoning, all-pervasive, technology that vastly extends what can be done to nature. He showed that technology, broadly conceived, is not simply a means to be used for good or ill, as is commonly assumed, but itself determines what we are. In considering the pervasive use of "values" and the fact-value distinction, he wrote,

> What is comic about the present use of "values" and the distinction of them from "facts", is not that it is employed by modern men who know what is entailed in so doing; but that it is used also by "religious" believers who are unaware that in its employment they are contradicting the very possibility of the reverence they believe they are espousing in its use. The reading of Nietzsche would make that clear to them.

Grant rejected the argument that the language of modern philosophy could be used "to present Christ in relation to all that is".

To explicate his argument, Grant knew that he must confront "the deepest criticism of ancient thought which has ever been made in the same of modernity": the writings of Heidegger. In his last years, he was engaged in that formidable undertaking, which, had he lived to complete it, would have been a major work. About this work he declared, "I do it out of my loyalty to Plato. Perhaps even more it is done out of loyalty to Christianity". In the introduction he had drafted for it, he wrote:

> To put it barely: the very clarity of Heidegger's incomparable thinking of historicism, from out of his assertion that human beings are only authentically free when they recognise that they are thrown into a particular historical existence, meets here the clarity of Plato's insistence that thought, at its purest, can rise above the particularities of any historical content, that indeed philosophy stands or falls by its ability to transcend the historical.... Heidegger states as the "all-decisive question": "What happens when the distinction between a true world and the apparent world falls away? What becomes of the metaphysical essence or truth?"

The modern paradigm of knowledge, in Grant's words, is necessarily lacking any sense of the beautiful and the good. Intimations of this deprival were felt by many of his students who had been schooled by that paradigm. For them Professor Grant opened a way to thinking about the apparent world that for these students was a revelation. They began to understand the relationship between theoretical knowledge and practical wisdom. As well, one always took classes with George Grant, not from him. Their gratitude and affection are a tribute to his life as a teacher.

Conversations with George Grant were memorable. His sense of the comic was infectious and he could energize any group with his gusto and perceptiveness. Yet he attended carefully to what others said and, like Céline, he cared about "what makes people tick". It is easy to understand his love of Céline,

about whom Jean Mambrino has written "...some deep instinct would cast him back into life with a kind of wild gladness".

George Grant's passion for the beautiful was kindled daily by the music of Mozart. His search for the means to bring together the Platonic love of the beautiful and Christian faith was aided immeasurably by Simone Weil. "What I intend by faith" he often stated, "is Simone Weil's definition: Faith is the experience that the intelligence is enlightened by love".

George Grant received much recognition in his lifetime, a lifetime that was far too short for his family, for whom he had a boundless love, his friends, and all those who attended to his work. He was elected a Fellow of The Royal Society of Canada in 1964. In 1981, he was awarded the Society's Chauveau Medal and was made an Officer of the Order of Canada. He was awarded honorary degrees by nine universities. The numerous conferences, sessions, and publications on his thought are a rare testament to his influence in Canada and abroad.

This great Canadian died of cancer in Halifax, 27 September 1988, facing death with characteristic courage. In an Appendix to an important long essay, "Faith and the Multiversity", George Grant touched on the relations between Christianity and philosophy. He wrote, "To speak of them elementarily: it is clear that Christianity is as much 'the practice of dying' as Socrates said that philosophy was." As he clearly exemplified in his own life, "the practice of dying" must be at the same time a celebration of life.

FRANCESS G. HALPENNY, C.C., F.R.S.C.

J. Russell Harper
1914-1983

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J. RUSSELL HARPER was born on a farm near Caledonia, Ontario, in Haldimand County, 13 April 1914. His education began in a one-room school and continued at Caledonia High School. In 1931-32 he attended normal school in Hamilton and then taught for one year. Deciding this career was not for him, he taught himself shorthand and typing. He worked as secretary for a lawyer, R.S. Colter, in Cayuga, Ontario, and when Colter was appointed to the Ontario Municipal Board in Toronto, Harper went there as a court stenographer. His interest in further education sent him as a part-time student to McMaster University, but these were depression years; lack of money and family difficulties did not allow him to continue. While in Toronto he took evening classes at the Ontario College of Art and there found the interest that was to dominate his later life.

In June 1942 Harper joined the Royal Canadian Air Force and served overseas as a radar mechanic on defensive stations and then with bomber squadrons. It was not work he enjoyed either mechanically or later as a matter of conscience. But there were compensations. His future wife Elizabeth Goodchild was serving in the British WAF and they were married 12 May 1945; she would be a devoted companion and helper in all his endeavours, and they would have a daughter Jennifer who took up photography as a career. In England, Harper seized every opportunity to visit museums, art galleries, antique and book stores, historic buildings. On his return to Canada the educational provisions for veterans made university possible. He received a B.A. in 1948 and a M.A. in 1950 from the University of Toronto (Victoria College) in art and archæology.

For a decade Harper now engaged in a variety of activities that developed his knowledge of art and archæology with a growing concentration on Canada. He was keeper of the Lee Collection of silver in Hart House, a cataloguer in the Royal Ontario Museum, and a member of archæological excavations in southern Ontario such as Serpent Mounds. From 1951 to 1955 Harper was with the New Brunswick Museum in Saint John, as curator of the Ganong Collection and again joining in archæological work, at Fort La Tour and Louisbourg. In 1956-57 a fellowship gave him a year's study in Paris, and another in 1957-58 supported work in Rome and Great Britain. For the Department of Indian and Northern Affairs he prepared in 1959 an important two-volume report on the potential for restoration of the Fortress of Louisbourg. All the while publications, typical of his breadth of cultural interest and his delight in historical research, were appearing: in 1954, to take one year, on an old Indian village of the Saint John River, on New Brunswick almanacs, and on theatre in Saint John 1789-1817.

A succession of senior appointments began in 1959: 1959-63, Curator of Canadian Art, National Gallery of Canada; 1965-68, Chief Curator, McCord Museum, Montreal; 1965-79, Professor of Art History, Sir George Williams University (later Concordia University), Montreal. From 1974 to 1983 he was a valued member of the advisory board of the *Journal of Canadian Art History* published at Concordia, in whose founding he was instrumental. His teaching at Concordia and the *Journal* were a culmination and vindication of his

conviction, and his personal demonstration, that Canadian art history must develop a full and sound base of knowledge and research. Concordia's graduate degree in Canadian Art History was the first in Canada. From this program were expected to come the trained researchers, teachers, and curators of the future. Harper's health had never been robust, and in 1979 he retired from the University to continue his many interests from the family's old log house outside Alexandria, Ontario, and then in South Lancaster.

It is his series of major works on Canadian art, in addition to a stream of articles and of catalogues for exhibitions as diverse as Homer Watson and Jean-Paul Riopelle, that have given lasting expression to Harper's discriminating appreciation of Canadian art and his constant search to know the social and cultural context within which its works of art have appeared. Of significant reference value were his *Historical Directory of New Brunswick Newspapers and Periodicals* (1961) and *Early Painters and Engravers in Canada* (1970). For 1966 the Canada Council, as its contribution to Canada's centenary, commissioned *Painting in Canada: A History/La peinture au Canada des origines à nos jours*, published by University of Toronto Press and Les Presses de l'Université Laval. The work was a first in its field. Planned as a comprehensive survey, based on research in documents and other previous scholarship, it would lay out the contours of "Canada's very considerable aesthetic achievement in painting" and be a background guide for the detailed study of particular artistic events and artists yet to come, and it was sorely needed. The book was also to be for the people of Canada, a purpose in writing style which suited Harper's own tastes; he was never one for the exclusive salon but wished to acquaint a general audience with their heritage. The impressive gallery of illustrations had been gathered from across the country, and the high-quality colour plates were printed, for the first time, in Canada. A revised edition was issued in 1977 and still circulates in paperback. The hope for further expert study of Canadian painting is being realized today by a new generation of scholars. In the Centennial year itself McGill University Press published *Portrait of a Period: A Collection of Notman Photographs 1856-1915*, with Harper as co-editor, another example of his wide appreciation for the different forms by which the people and places of Canada's past are recorded.

Paul Kane's Frontier (1971) was another commission, this time from the Amon Carter Museum in Texas and the National Gallery of Canada. It set Harper upon a characteristic hunt for evidence about Kane's accounts of his western travels on the fur trade pathways and his subjects among native peoples and western landscape, including a personal retracing of Kane's routes, a careful examination and accounting for the watercolours and oils, and a *catalogue raisonné* that linked the sites and people described in Kane's *Wanderings* with these works. The book's copious illustrations were a treasure. In the 1980s a number of scholars, whose work Harper would have relished, have continued to study Kane, analyzing 19th century landscape conventions in art and using textual criticism to trace the likely composition of his text. Harper had once more been a pioneer.

His technique of careful preparation and presentation for a general as well as a scholarly public were evident again in *Krieghoff* (1979), a complex study because of the artist's vast output and popularity with copyists or forgers over the years and because of his repetition of subject-matter. It was a study intended to place Krieghoff in relation to his time and his patrons, and to our own time.

Harper's later years were marked by his interest in the art of Canadians that had originated at the grassroots level — not surprising for someone whose approach to art history gave such attention to society. In 1973 he selected for the National Gallery an exhibition on "people's art", that is, on "primitive", "naïve", "provincial" and "folk" art — he was wrestling with the terms. *A People's Art*, following on from this exhibition, was published in 1974, and he continued to study and write on this subject. The 1973 exhibition, with its blaze of uninhibited joyous colour on the walls and its wonderful shapes, excited and inspired viewers on its cross-country tour. In the autumn of the year of Harper's death no fewer than three imposing books demonstrated the recognition people's art had achieved.

Russell Harper was a Doctor of Letters, University of Guelph (1972), a Fellow of The Royal Society of Canada (1974), an Officer of the Order of Canada (1974), and a Doctor of Fine Arts, Nova Scotia College of Art and Design (1982).

DIGBY J. McLAREN, O.C., F.R.S.C.

James Merritt Harrison
1915 - 1990

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

JAMES MERRITT HARRISON suffered a bicycle accident on 18 April 1990 and remained in a coma until he died on 6 July 1990. Jim Harrison had a long and successful career as a scientist and as an influential manager and policy-maker both nationally and internationally. He was one of those rare people who appeared at the right time in the right place. He was a natural leader, reacting to challenge apparently effortlessly, decisive, intelligent, confident and humane. He possessed an inner strength that never failed him. His life was shaped and influenced by his links to the Geological Survey of Canada and he served it well.

He took a B.Sc. at the University of Manitoba in 1935, and a M.A. in 1941 and a Ph.D. in 1943 from Queen's University. In the same year he joined the permanent staff of the Geological Survey. A competent "hard-rock" geologist, he produced authoritative reports on mineral-bearing regions of the Canadian Shield in Manitoba, and subsequently became an authority on the banded iron ore formations in Labrador. His work was central to the exploration and subsequent development of the rich ores in that region. His competence gave him the necessary authority as a manager when, in 1956, at the age of 41, he was appointed Director of the Geological Survey. It would be hard to exaggerate the importance of his appointment at that time. Hume, Bell and Hansen, the previous three Directors, had recognized the need for innovative approaches in dealing with the revolution in post-war geology. Harrison accepted this challenge, and as Director for eight years, with Cliff Lord as Chief Geologist, he consolidated and extended processes already begun. These challenges included: the need to map the "third side" of the continent (the whole of the Canadian Arctic); to study the geology of the continental shelves and slopes; to extend and develop techniques of large airborne field operations; to increase research and applications of geochemistry and geophysics, including geophysical instrumentation; development and exploitation of new techniques in age determination; and improved data processing.

When Yves Fortier became Director in 1964, Harrison was able to continue his remodelling and expansion of the Earth Sciences from the position of Assistant Deputy Minister in the Department of Mines and Technical Surveys. Here he was able to exercise his skills, which developed rapidly, in dealing with senior bureaucrats and politicians. Through his activities, the role of the Geological Survey was understood by the public and by politicians better than ever before. Because good science was performed, it was recognized that geology requires a deep theoretical basis if it is to be also an important applied science. Support from government and from the petroleum and mining industries grew, and the Survey enjoyed one of the most successful periods in its history.

During the sixteen years that Harrison was a manager, within the Canadian Department of Mines and Technical Surveys that evolved during that period into Energy Mines and Resources, the Geological Survey more than doubled its staff, greatly increased its budget, moved to its new headquarters on Booth Street in 1959, and further decentralized many of its activities across the country, with divisions in Vancouver/Victoria, Calgary and Halifax. The

organization flourished and extended its reach world-wide, both in assisting developing nations and in international science organizations. Here also Harrison became a leader. He was the first President of the International Union of Geological Sciences and as a result the Geological Survey was encouraged to exercise leadership in many areas of global research and development.

It is ironical that the time of his retirement from the Department corresponded approximately with the Glassco Commission report, shortly to be followed by the Lamontagne Commission report. The first of these ushered in an era of management systems that tended to emphasize process rather than product, and the second carried the arguments on the distinction between pure and applied science to extreme limits, the repercussions of which are still reverberating. The golden age was over.

One should pause and analyze what enabled Harrison to so affect an old and perhaps conservative organization and to stimulate it to become a world leader. Firstly he was a good scientist. He served his apprenticeship in the field in research and acquitted himself well. This gave him the necessary authority as a manager — a leader in science among equals. Secondly, he was deeply interested in his subject and ever ready to discuss problems and theories and to learn from the experts he directed. Thirdly, and perhaps the most important single virtue in a manager, he backed his staff and no matter what disagreements there may have been over administrative programs or budgetary planning, no one doubted for a moment that he was in there, fighting for science and the scientist and the importance of research. As a bonus he was also unusually good at explaining and justifying programs to the public and politicians.

Harrison then moved on. In 1973 he was appointed Assistant Director General (Science and Technology) to Unesco. He was in charge of programs in the teaching of science and engineering and in the operation of scientific, engineering and technological projects, directed mostly to developing countries. During his tenure he visited between thirty and forty countries on Unesco business. He found his position challenging and satisfying, but also perhaps one of the most difficult assignments he had yet handled — in an institution where the reasons for decision making were not always apparent.

Returning to Canada in 1976, he worked for the rest of his life as a consultant in geology and science management visiting no less than some twenty countries in Europe, the Middle East, Africa, Southeast Asia, China, Japan and the Philippines for such organizations as Unesco, UNDP, UN University, UN New York, the Asian Bank, IDRC, Kenting Earth Sciences Ltd., and others. He chaired an international group under the International Council of Scientific Unions on disposal of high-level radioactive waste and of another on the disposal of other hazardous wastes. He was Chairman of the Board, Science Institute of the Northwest Territories, and President of the Canadian Commission for Unesco.

During his career, Jim Harrison received many honours including six honorary Doctorates, and many institutional distinctions. He was a Companion of the Order Of Canada (1971), a foreign associate of the National Academy

of Science, U.S.A. (1965), and he was President of The Royal Society of Canada (1967-68). Of many medals one should mention: the R.C. Wallace Medal, University of Manitoba; the Achievement Award of the Public Service of Canada; the Logan Medal of the Geological Association of Canada; the Blaylock Medal of the Canadian Institute of Mining and Metallurgy; and the Kemp Gold Medal, Columbia University.

On 5 May 1944 Jim Harrison married Herta Sliter, and they were close to celebrating their fiftieth anniversary when he died. Herta was a source of strength and encouragement throughout his career, and took a particular interest in the Geological Survey staff. She was very active in the Geologists Wife's Club of the Survey and did much to engender the *esprit de corps* and morale of the organization. She continued her interest long after he had moved to other responsibilities. Our sympathy goes out to Herta and to stepson Norman and his wife Bette, their children and grandchildren.

Jim Harrison was a close personal friend, and will be sorely missed by many of us. To meet and talk with him was always a pleasure. He was warm, friendly and liked to laugh. Underlying the surface, however, was a steely determination to do what was right and what was needed. He would ask advice and debate issues, but he made the decisions. He loved controversy and accepted the fact that many of the best scientists are not easy to get along with. When necessary he could be hard. He has left a memorial behind which extends across the world and involves all classes and kinds of human beings. We mourn his loss, but we are glad he lived; he enriched the world he knew and loved.

C.T. BISHOP, F.R.S.C.

John William Hopkins
1908 - 1989

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

JOHN WILLIAM HOPKINS was born in Leeds, United Kingdom, on 15 June 1908. He came to Edmonton, Alberta, with his parents in 1924 and obtained his B.Sc. degree in Agriculture from the University of Alberta in 1929, winning the Governor General's Gold Medal and the Vallee French Prize. In 1931 he obtained a M.Sc. in Cereal Chemistry. It was during this period that he showed interest and ability in assessing the quantitative aspects of scientific investigations. This talent drew him to the attention of Dr. Robert Newton who had recently been appointed Director of the Division of Biology and Agriculture of the National Research Council. Dr. Newton, a distinguished plant biochemist at the University of Alberta, had begun to assemble a small group that would move with him to Ottawa when the National Research Council building was ready to accommodate them. John Hopkins was one of these (others were J.A. Anderson, W.H. Cook, G.A. Ledingham, J.G. Malloch, and F.H. Peto), and was encouraged by Newton to apply for doctoral research under R.A. Fisher of Rothamsted Experimental Station in England. Fisher was the leading statistician in the world, specializing in agricultural sciences. Hopkins was awarded his Ph.D. (University of London) in 1934 by which time he had already returned to Canada to join Newton and his colleagues at NRC in Ottawa.

Hopkins' initial, main line of research was agricultural meteorology, particularly as it related to crop plants in the western provinces. An overview of this research can be gained from a perusal of the titles of his papers, e.g. "Influence of Weather Conditions on the Nitrogen Content of Wheat" and "Weather and Wheat Yields in Western Canada". He analyzed masses of the published official data with the aim of increasing the accuracy of existing methods for forecasting agricultural production figures. His results showed that still more data would have to be processed before reliable predictions could be made.

During most of this period Hopkins was the only statistician in NRC and indeed he was one of only two "Fisher-trained" statisticians in Canada. It is therefore not surprising that he was widely consulted both within NRC and ouside. One of his major "outside" projects was a collaboration with the Associate Committee on Medical Research on the assessment of J.A. Baudoin's mammoth experiment on BCG antituberculosis vaccination of school children. This work, begun in 1925, involved analysis of the collected observations on hundreds of vaccinated subjects and unvaccinated controls. At the request of the Associate Committee, Hopkins analyzed the data from a selected subset and was able to substantiate Baudoin's findings that vaccination was effective and resulted in about 70 percent less tuberculous morbidity and mortality than in the control groups.

During 1933-34, the Division in Ottawa was asked to undertake tests on the reliability and calibration of several different types of electrical moisture meters, designed for use with cereal grains. Hopkins was responsible for the statistical analysis of this work.

With the outbreak of World War II, Hopkins became deeply involved in the Division's research on improved methods of food preservation and

transportation. Many subjective tests on food items were required, and the large mass of data so generated had to be reduced and tested for significance by statistical analysis. The scarcity of statisticians in Ottawa, and indeed in Canada, brought an increased demand for Hopkins' skills. He worked with the Physiological Section of the Chemical Warfare Establishment on the dimensional sizing of gas masks and with the Army Nutritional Survey on the storage quality of army rations. Hopkins' contributions to such subjects were so valuable that he was invited to join the operations research group of the Department of National Defence. After a year's work on anti-submarine warfare off our coasts he was tranferred to England where he was attached to No. 6 (Canadian) Bomber Command, assessing their operations and bombing patterns. In recognition of his sevices he was made an Honorary Wing Commander and, after the war, was awarded the M.B.E.

On his return to NRC, towards the end of the war, Hopkins began further work on the statistical aspects of taste panels and established a section that offered statistical services to other groups in the Division of Applied Biology. This took the form of advice on design of experiments and analyses of results in areas as diverse as bacteriology, spectroscopy, and physiology. In 1953 he was a consultant to the government of Burma on the conduct of a census. Always active in his professional community, Hopkins was a member of the Biometrics Society, its Treasurer (1949-51), and editor of *Biometrics* (1956-67). He was also a member of the Institute of Mathematics and Statistics, the Royal Statistical Society and the International Statistical Institute; a Fellow of the American Statistical Association (1949) and a Fellow of The Royal Society of Canada (1950).

Hopkins was dedicated, conscientious, and hardworking, but always considerate, patient, and polite. He was blessed with a keen sense of humour augmented by a fluent and precise use of the English language. This made him a formidable and delightful conversationalist who brightened many a day. In the early days of Hopkins' employment at NRC, the country was in the depths of the depression and government salaries were cut by ten percent one year. When the following year it was announced that salaries would stay the same and there would be no cuts, Hopkins referred to the situation as "The Great Leap Forward". On his retirement from NRC in 1973, after 43 years of service, a colleague asked about his health; Hopkins' reply was typical of the man, "At my age one has to face metabolic reality".

With the death of John W. Hopkins on 9 May 1989, Canada lost a prominent scientific pioneer who contributed greatly to his chosen field and to the national good. He is survived by his wife Kathleen Ellis Hopkins and son, John Ellis Hopkins.

E.T. TOZER, F.R.S.C.

J.A. Jeletzky
1915 - 1988

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

JURIJ A. (GEORGE) JELETZKY, an internationally recognized geologist and paleontologist, a Fellow of the Society since 1970, died in Ottawa on 4 December 1988. Dr. Jeletzky was born Jurij Alexeyvich Romanov at Penza, Russia, on 18 June 1915. In 1930 he took the name Jurij Alexandrovich Jeletzky, upon adoption by his stepfather. When he came to Canada he exchanged Jurij for George and by that name became known to a host of friends and colleagues throughout the world.

His professional training was in Kiev. He graduated as a geologist in 1938 and completed his graduate work in 1941. For fifty years he was actively engaged in research in stratigraphy and paleontology. His early years of professional activity were in Russia, Poland and Germany. He was in Kiev when that city fell to the German armies in September 1941. He continued geological work under the German occupation until the return of the Soviet Forces in 1943 when he moved west, first to Poland, then to Germany. At times he worked as a librarian but throughout these difficult times he managed to keep, not only his family together, but also his collection of Cretaceous belemnites. Several publications on the Cretaceous stratigraphy and belemnite faunas of Europe resulted from this early work. George's achievements during this difficult period testify to the fortitude and determination that all his colleagues knew and respected.

In 1948 he came to Canada where employment with the Geological Survey of Canada had been arranged. He remained associated with this organization until his death, for, although he officially retired in 1981, he continued to work energetically, in spite of debilitating illness, until a few days before his death.

At the Geological Survey he was responsible for Cretaceous stratigraphy and molluscan faunas, not only those that he collected himself, but also large collections submitted for his assessment by colleagues, Provincial Surveys, and oil and mining companies. His international reputation also led to his working on collections submitted by the Deep Sea Drilling Project.

His interests and activities have made major impacts in several different areas of geology. His first field work in Canada was on Vancouver Island and he maintained an interest in its geology throughout his life. Although his original task was to determine the Cretaceous successions, he elucidated the whole Mesozoic and Cenozoic history bringing our knowledge of the stratigraphy of the Island to a state unmatched in the whole of the Cordillera. I write with some authority on this matter because it has fallen my lot to study the outstandingly important collections of Triassic fossils which he obtained, with important data on sequence, derived from his study of an area of great structural complexity. George's work on Vancouver Island led him to make further studies on the correlative rocks on the mainland of southern British Columbia.

The second main area of his field activity was the northern Yukon where he made many new finds, for example, the first discovery of marine Hauterivian, Barremian and Aptian deposits.

George was always one to enjoy challenge and controversy. His stratigraphic work, generally in areas of structural complexity, whetted his

interest in tectonic problems. Similarly his work on correlating with fossils led him to write extensively on paleogeography, paleozoogeography and eustasy.

His paleontological research was mostly on Mollusca, particularly Bivalvia and Cephalopoda. Notable was his work on *Buchia*, the bivalve so important in Upper Jurassic-lowermost Cretaceous biochronology. For this he worked not only on his own collections but on material from all over the world, and devised a biochronological scheme of international significance more refined that hitherto available. He studied and published extensively on Lower Cretaceous ammonites. This research provided critical data for defining and correlating the Jurassic-Cretaceous boundary beds.

He also made notable contributions to the study of another group of cephalopods, the Coleoidea, which include the belemnites, his first love. He was early recognized as the principal authority on this group and invited to coordinate the Coleoidea volume of the "Treatise on Invertebrate Paleontology". Although this volume has not appeared, George published substantially on coleoids of all the Mesozoic systems from all over the world in an effort to "clear the air" in preparation for the publication of this definitive summary. Much of his work on the belemnites is in manuscript form but hopefully it will be published posthumously.

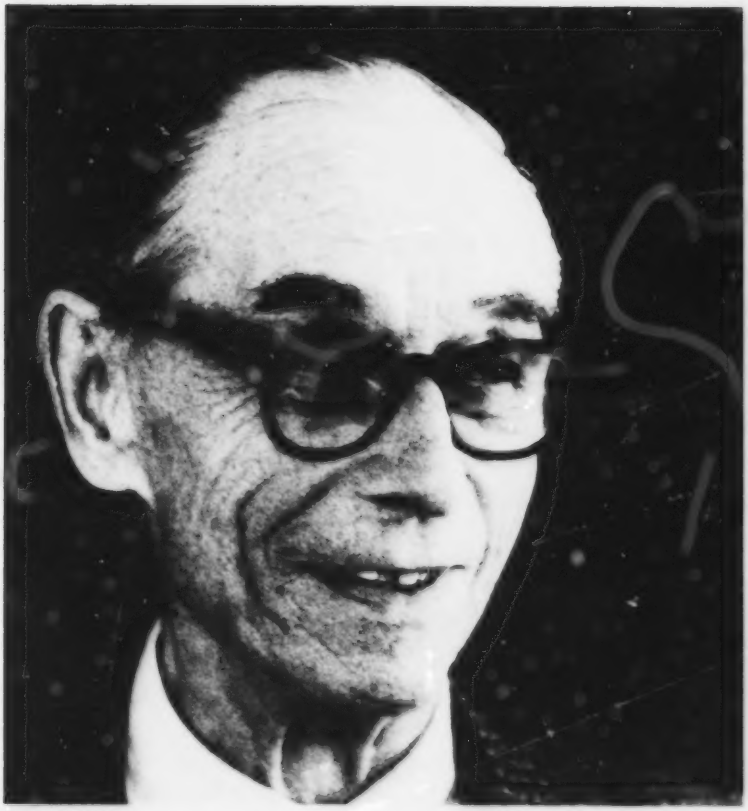
No account of his activities would be complete without mention of his writings on the methodology and philosophy of biochronology in which he aggressively and effectively championed the unmatched, and he would probably say unmatchable, role that fossils play in the establishment of the Phanerozoic time scale.

For all this he has been rightly honoured. In 1969 he was The Willet G. Miller medalist of the Society and in 1978 he was the first recipient of the Elkanah Billings Medal of the Geological Association of Canada.

He is survived by his wife, Tamara, two sons and a daughter. He was predeceased by another daughter, Lila, who was also a geologist.

MAX DUNBAR, O.C., F.R.S.C.,
and MICHAEL J. KEEN, F.R.S.C.

Ernst Håkan Kranck
1898-1989



TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

ERNST HÅKAN KRANCK, Professor of Petrology in the Department of Geological Sciences at McGill University from 1948 to 1969, died in late May 1989 at the age of 90. He was a man whose achievements outran his public recognition because of his innate modesty — the "bubble reputation" never bothered him. He was born in 1898 in Birkala, Finland, son of an architect, E.A. Kranck, and Alexandra Lisitzin. He attended the University of Helsinki and was awarded the doctoral degree in 1933. After several academic appointments he was chief geologist of the Vuoksenniska Company in Finland from 1940 to 1945. After the war he served as Professor of Geology at the University of Neuchâtel in Switzerland. His teaching career at McGill University began in 1948 when he was invited to come to Canada as a Visiting Professor. He was elected a Fellow of The Royal Society of Canada in 1982.

Håkan Kranck was an outstanding field geologist and geographer. He participated and led expeditions in Labrador, Baffin and Axel Heiberg Islands, Ontario, Newfoundland, Russia, Finland, Patagonia, and Scotland. As a 19-year old student he was a member of an expedition to Urjanchai on the boundary between Siberia and Mongolia. That was in 1917, and the account of the expedition became as much a study of the Russian Revolution as of the geology of the region. In 1979 he published the story of that trip entitled *Den Stora Urjanchai-Expeditionen, 1917* which deserves, even for its humour alone, to be translated into English. About a visit to the Academy of Science Museum in Leningrad he wrote: "An enduring memory of the building was my first meeting with the oriental cockroach (*Periplaneta orientalis*) represented by an impressive 4-cm long specimen... The funny thing is that the next time I met this creature was at the entrance to the geological library at McGill University in Montreal, half a century later. The species clearly has a certain attraction to academic surroundings." Notes from his field work in Lappland to investigate iron ores record that "Food was scarce (in the postwar world), but we had a good time and hiked across the greater part of Lappland".

His field work in Canada began in 1925 with geological mapping at Steep Rock Lake, Ontario. In 1928-29 he was working in Patagonia on an expedition of the Geographical Society of Finland. From his unpublished diary of this expedition came many pen-and-ink sketches for which he became well known. In 1937 he was a member of the Tanner Finnish expedition to Labrador and was again in Labrador in 1939. On the 1939 expedition he used his own motor launch *Markland* that he brought from Helsinki. The boat was launched from a freighter in Strait of Belle Isle and he entered Battle Harbour early one foggy morning to the astonishment of local harbour officials who found him flying the Finnish flag and making breakfast (described in *With Motor and Hammer along the Labrador Coast*, in Swedish). After many field trips to Lappland and Finland between 1941 and 1944 and field work in Switzerland (1945-46), he came back to northern Canada in 1947 to work along the east coast of Hudson Bay in freight canoes on a grant from the Arctic Institute of North America.

After coming to McGill he continued his field work in Labrador with a coastal expedition using the *Merry Gale*, a boat he described as "not exceedingly seaworthy", and in 1950 he joined the Pat Baird expedition to Baffin Bay

(Penny Highlands). He was in Labrador again in 1951, northern Newfoundland in 1953, and back to Labrador in 1954. In 1959 he joined George Jacobsen in work on Axel Heiberg Island at the newly established research station, and finally, he went back to Baffin Island again in 1972 at the age of 74.

His teaching and research spanned many continents, countries, languages and disciplines. He taught in Finnish, Swedish, French and English. He learned geography on the job when charged with teaching Economic Geography at a Swedish college of commerce in Helsinki. The subjects of his papers range from Tierra del Fuego through the Antilles to Baffin Island, from radiolarian-bearing rocks to beryl-bearing pegmatites. He was a friend and acquaintance of individuals who now seem heroes of long ago, Koch and Wegmann, for example. Perhaps it was his wealth of experience which let his mind range so freely.

Geologists and geophysicists today are impressed with the interesting geological comparisons he made between western Greenland and coastal Labrador. During his earlier career the idea of continental drift was regarded with amusement by most geologists in the northern hemisphere. On the whole only those who worked in the southern hemisphere and were impressed by the similarities between the southern continents used the idea as a reasonable working hypothesis. Håkan Kranck, like the visionary southern geologists, looked at the evidence that lay before him. He told us in 1939 that "...there seems to exist a good correspondence as regards geological events during Pre-Cambrian time on both sides of the Labrador Sea..." and he speculated on the timing of separation.

Commenting on his early years at McGill and the growth of the Department of Geological Sciences with a small but expert staff, over 50 undergraduates and a large group of graduate students, he wrote: "Somehow it worked ... The main assets of a university are good students ... Professors are useful mainly as advisors". During this very active life, Håkan Kranck produced three books and numerous scientific papers; he also made many friends.

PIERRE DANSEREAU, C.C., m.s.r.c.

Léon Lortie
1902-1985

MÉMOIRES DE LA SOCIÉTÉ DU CANADA / SÉRIE VI / TOME I / 1990

Né à Montréal le 31 août 1902, LÉON LORTIE suit le cours classique, chez les Jésuites, au Collège Sainte-Marie. Il faut se rappeler le peu d'importance que ces écoles accordaient aux sciences pour mesurer l'originalité de l'attirance pour la chimie de ce collégien, et se demander d'où lui venait une telle inspiration. On est tenté d'y répondre en lisant sa biographie à l'envers, et en faisant l'hypothèse d'une vocation sociale aussi précoce que son orientation scientifique.

En effet, cet étudiant de 21 ans qui s'inscrit à la toute nouvelle Faculté des Sciences de l'Université de Montréal en 1923 est déjà aussi passionné pour le rôle pédagogique et historique des scientifiques que pour les secrets de la matière qui lui sont révélés dans son apprentissage de chimiste. Ce sera bien souvent, par la suite, qu'il fera connaître les chimistes autant que la chimie à ses auditoires. En tout hommage à la formation classique, cette incarnation de la science qui lui fut inculquée au collège devait s'affirmer tout au long de sa carrière.

Il obtint donc sa licence ès sciences chimiques à l'Université de Montréal en 1927, y ayant déjà été engagé comme chargé de cours. En 1928, il prépare sa thèse sur le cérium à l'Université de Paris sous la direction de Georges Urbain. Docteur en Sciences Physiques en 1930, il poursuit sa formation par des études postdoctorales à Cornell University (1930-1931). Revenu à l'Université de Montréal, il enseigne non seulement la chimie générale mais l'histoire de la philosophie des sciences, comme chargé de cours (1931-1935), professeur agrégé (1935-1944), professeur titulaire (1944-1962).

Au cours de ces années 1931-1962, Léon Lortie est un des universitaires les plus présents dans le milieu social. Il mettait en pratique sa conviction que le témoignage scientifique avait un rôle constructeur à jouer hors les murs de l'académie. Il se mettait d'abord à l'épreuve de participer à l'enseignement secondaire : Collège Jean-de-Brébeuf (1931-1932), Collège André-Grasset (1932-1942), Catholic High School of Montreal (1942-1945). Sa participation aux émissions radiophoniques de Radio-Collège faisait partie d'une innovation mémorable de vulgarisation scientifique qui rejoignait les milieux scolaires les plus éloignés et mettait les jeunes en présence des hommes de science les plus authentiques : Marie-Victorin, Louis Bourgoin, Léo Pariseau, Jacques Rousseau, et plusieurs autres.

Très actif dans le journalisme étudiant au début des années 20, Léon Lortie a toujours été présent dans les pages éditoriales des journaux, dans les panels et débats d'abord radiophoniques et puis télévisés. Ses contributions aux encyclopédies pour les jeunes furent aussi remarquables.

Plus tard (années 40 et 50), il est un des dirigeants de la Société d'Éducation des Adultes du Québec, du Conseil Canadien pour la Reconstruction par l'UNESCO, de l'Institut Canadien des Affaires Publiques. Sa présence dans les assises de l'ICAP aura donné à cet organisme précurseur de la «révolution tranquille» une solidité d'information et de pensée de grande valeur.

Il faut rappeler que l'autorité qu'il apportait à ces diverses entreprises para-universitaires lui venait du respect qu'il avait acquis dans sa profession de chimiste, comme en témoignent les postes qu'il a occupés dans les corps

professionnels : Société de physique et de chimie de Montréal (président, 1931, 1934, 1935; secrétaire 1937-1946); section de Montréal de la Society of the Chemical Industry (président, 1939-1940); Canadian Institute of Chemistry (président 1942-1943); Chemical Institute of Canada-Institut de chimie du Canada (membre du conseil d'administration, 1943-1949, président 1946-1948); l'Association scientifique franco-canadienne; la Société royale du Canada (président 1968). Quant à l'Association canadienne-française pour l'Avancement des sciences (ACFAS), présent à la fondation, il contribua beaucoup à l'organisation des congrès, et il en fut président en 1948.

Mais c'est l'œuvre tout entière de l'Université de Montréal qui lui tenait le plus à cœur. Au cours des longues années d'activités si variées, il a toujours assidûment valorisé sa fonction de professeur. Nombreux sont les anciens étudiants aujourd'hui «chevronnés» à qui il aura révélé leur vocation. On peut dire que c'est son exemple autant que son enseignement qui les aura portés vers une carrière scientifique dont les conditions matérielles étaient si pénibles jusque dans les années '50. Cette Université de Montréal il l'aura donc servie sur tous les plans, en tant que professeur, représentant à l'extérieur, conférencier, participant aux travaux des sociétés savantes, conseiller municipal (1944-1960, puis 1966), directeur du Service d'extension de l'enseignement (1952-1962), adjoint au recteur (1962), secrétaire général (1962-1968). Il prenait sa retraite en 1968, et se consacrait alors à la rédaction d'une histoire de l'université qu'il n'a pas achevée, peut-être parce qu'il continuait d'être présent trop assidûment à tous les problèmes de l'heure, surtout ceux de l'éducation.

Léon Lortie a reçu des doctorats honorifiques de plusieurs universités : Ottawa (1949), Caen (1957), McGill (1966), Laval (1969), Montréal (1972). Il était membre de l'Ordre du Canada et avait reçu la médaille du Centenaire de la Confédération. Or, tout récemment, la Société Saint-Jean-Baptiste créait le prix Léon-Lortie pour honorer annuellement un scientifique.

Léon Lortie a vécu une carrière exemplaire dont chaque étape préfigurait les accomplissements de la suivante. Ce que j'entends par là, c'est que sa confiance dans l'avenir et sa vision du devenir culturel canadien-français le portait à s'engager dans des activités de précurseur. Scientifique, éducateur, vulgarisateur, encyclopédiste, humaniste, animateur, administrateur, il a joué tous ces rôles au moment même où leur définition était mal connue et où leur influence n'était pas acceptée par notre société.

Quelle foi dans la science ne fallait-il pas à un élève des Jésuites, pour oser faire une carrière en chimie, sans passer par la médecine ni le génie? Il fallait que cet adolescent fut déjà profondément ému par l'image et la démarche de Lavoisier comme ses condisciples l'étaient par celles de Victor Hugo et autres grandes figures littéraires qu'honorait le «cours classique».

Il avait eu l'audace de chercher à Paris et à Cornell une instruction et des contacts qui lui offraient l'épreuve d'une densité de pensée et d'une force de discipline à laquelle tous les «anciens d'Europe» n'auront pas su se plier. Comme d'autres qui l'ont suivi, il était revenu à Montréal avec le dessein d'implanter cette rigueur dans une université où régnaient l'improvisation et

la bonne volonté. Il aura alors projeté cette image de l'engagement universel et valorisé l'expérience vécue en présence de plusieurs générations d'étudiants qui émergeaient d'un système d'éducation qui refusait l'humanisme scientifique. La société canadienne-française tout entière, avant 1930 (avant 1950?), en était à l'agriculturisme.

Léon Lortie devait, toute sa vie, fournir la preuve qu'un scientifique, ancré dans une tradition mondiale et internationale, avait une contribution indispensable à faire à la société dont il était solidaire. Grand érudit, il savait repérer, dans des entretiens radiophoniques, les origines de toutes les inventions qui sont à notre service et les précédents de toutes les problématiques servant à formuler nos besoins et à prévoir l'avenir.

Sa contribution aux encyclopédies populaires, aux conférences de vulgarisation, aux forums d'affaires publiques, à l'éducation des adultes était fortement nourrie par sa capacité de puiser spontanément dans le grand trésor de la connaissance universelle. Il aura sans doute été le plus grand érudit de sa génération, mais pas un érudit anecdotique. Il était, au plein sens du mot, un savant qui pouvait faire ressortir la relation entre Anaximandre et Darwin de façon à les rendre tous deux présents. Les apprentis de la science pouvaient voir en lui ce grand bonheur de la conspiration scientifique qui lie les générations et les cultures.

Le milieu scientifique québécois (et canadien) n'a pas produit beaucoup d'hommes de cette trempe. La science qu'il aimait partager trouvait des auditeurs et des interlocuteurs d'autant plus avides que Léon était toujours accueillant. Ceux qui ont eu le bonheur de son amitié et connu l'accueil de son foyer et de sa famille y auront puisé une confiance qui les aura laissés mieux armés pour les tâches difficiles qui exigent le dépassement.

HOMER A. THOMPSON, F.R.S.C.

Malcolm Francis McGregor 1910-1989

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

In the death of Professor MALCOLM FRANCIS McGREGOR on 10 November 1989, the English-speaking world has lost one of its most colourful, vigorous and effective exponents of Classical studies. McGregor will be remembered especially as a research scholar and teacher with interests strongly focused on the history of Athens in her great days.

Born in London in 1910 of Scottish parents, McGregor emigrated to Canada at age fourteen, attended high school in Vancouver and proceeded to The University of British Columbia. Having taken his B.A. in 1930 and his M.A. in 1931 at U.B.C., largely under the persuasive influence of Professor Harry T. Logan, McGregor was committed to a career in Classical studies. After two years of graduate work at the University of Michigan (1931-33) he moved on to the University of Cincinnati to take his Ph.D. (1937).

The move to Cincinnati was to be decisive for McGregor's career. Working closely with Professor Alan B. West he inevitably became involved in a great project that had been taking shape through the collaboration of two American scholars, West and Benjamin D. Meritt, with H.T. Wade-Gery of Oxford. Their objective was a comprehensive new picture of the Athenian Empire in the fifth century B.C. in the making of which the evidence of the contemporary inscriptions would play a much larger role than ever before as a supplement to the familiar account by Thucydides. This called for more systematic and thorough examination of the shattered stelai on which had been engraved much of the financial record of the Empire. Fragments of these stelai, the "Athenian Tribute Lists", were still coming to light, and McGregor's first contribution was a summer spent in Athens poring over the stones (1933). When Alan West was killed in a car accident in 1936, his material was turned over to McGregor. The young scholar was taken on as a member of the team by Meritt and Wade-Gery, a triad that worked harmoniously and fruitfully together in the production of the four volumes of *The Athenian Tribute Lists* (1939-1953). The story of the Athenian Empire was to be the leitmotif for the rest of McGregor's career in both research and teaching.

In his 21 years in Cincinnati, McGregor taught for 18 as a faculty member in Classical and Ancient History, serving also as Acting Dean of the Graduate School of Arts and Sciences (1941-42).

The year 1954 saw him back in his *alma mater*, The University of British Columbia, to be Professor of Classics until his retirement in 1977; he had headed the Department for the first 21 of those years. He served the University well in various other capacities: assistant to the dean, director of residences and of ceremonies, and member of the university senate.

But McGregor's heart was above all else in his teaching as recognized by the Walter Koerner Master Teacher Award (1974). His legendary lecture courses in ancient history owed their appeal in great part to his own participation in the research on which they were largely based. His flair for popular writing led to his vigorous role as faculty advisor on student publications. Although undergraduates of the 1960s and 1970s may have been irked at times by a student-teacher relationship reminiscent of English public schools of

Victorian days, they could not but be impressed by their teacher's devotion to both his subject and his pupils.

In addition to his long and nearly equal appointments at Cincinnati and U.B.C., McGregor enjoyed shorter contacts with a number of other institutions. Among these was the American School of Classical Studies at Athens, a convenient base for the study of the Tribute Lists. He served the School as a Visiting Professor (1967-68) and for many years as a member of its Managing Committee including a stint as Chair of the Committee on Admissions and Fellowships (1972-75). Membership of the Institute for Advanced Study in Princeton (1937-38) facilitated collaboration with his colleagues on the Tribute Lists project.

McGregor was an inveterate traveller. He loved also to keep in personal touch with distant colleagues who shared his interests. This induced him to accept visiting professorships or lectureships in many places in Canda and the U.S.A. as well as in Oxford, Cambridge and London. In some of the host institutions his visits came to be regarded as a tonic and were repeated time after time. He was indeed a compulsive teacher. After retirement from U.B.C. in 1977, he taught for years at the Vancouver Community College (Langara Campus).

McGregor's principal contribution to scholarship was undoubtedly his part in the making of *The Athenian Tribute Lists*. The division of labour is not indicated in the volumes, and the text itself is seamless, but all three authors contributed to the successful completion of what is rightly regarded as one of the most remarkable examples of "team scholarship" in the history of Classical studies. The first task was to make sure of the readings and to recover the relative positions of the inscribed fragments of the marble stelai recording the tithes paid to the goddess Athena out of the annual contributions of the member states of the Empire, just over 200 in number at its height. The first of the several stelai stood twice the height of a man and was inscribed on all four sides. Although much is lost, some 180 fragments have been recognized and re-assembled. The restored stele is an awesome monument both to ancient bookkeeping and to modern scholarship. Through the judicious exploration of this very first-hand evidence the authors have greatly enriched our picture of the Empire, of its economy, its administrative machinery and its temper. Their labours were crowned by the Goodwin Award of Merit from the American Philological Association in 1954.

After the publication of *The Athenian Tribute Lists* McGregor dealt from time to time with problems of detail in journal articles. He took particular pleasure in being associate editor of a volume in honour of his beloved role model: *Phoros: A Tribute to Benjamin Dean Meritt* (1974). His reviews of books were an impressive part of his output, upwards of 150 in number, the great majority concerned with Greek history and literature. Many of these reviews appeared in journals read chiefly by teachers with whom he was always glad to share his special knowledge.

McGregor's long preoccupation with ancient Athens culminated in a highly personal statement: a trim volume entitled *The Athenians and Their*

Empire (1987). The author has produced a very readable history of the Empire from its beginnings early in the 5th century B.C. to its collapse at the end of the century. Unburdened by a single footnote the book is intended primarily for the non-specialist. But even the most learned will profit from the author's mature assessments of the great issues and personalities and, above all, from his judicious balance sheet of the faults and virtues of the Athenian Empire. His sensitive observation of the rise and fall of empires within his own life time added both breadth and depth to his understanding of the ancient Athenian experience.

As a born leader with a fertile mind and tireless energy, McGregor supported the Classical cause through virtually all the relevant organizations on this continent: the Ohio Classical Conference (Secretary-Treasurer 1949-54); the Classical Association of Canada (President 1968-70), and the Editorial Advisory Board of the Association's journal, the *Phoenix*; the American Philological Association (President 1969-70); the Classical Association of the Pacific Northwest (President 1972-73).

Nor did he neglect community affairs, having served as a member of the Board of Directors of the British Columbia Centennial Committee and as Chair of the Joint Board of the Teacher Education Committee to study the "Education and Training of Teachers in British Columbia".

When asked why he forsook Cincinnati and returned to Vancouver, McGregor replied "So that I can play cricket". That may not have been the whole truth, but it is a fact that from 1954 to the end of his life he was very supportive of the game, not only playing himself but also as an officer of the B.C. Mainland Cricket League and the B.C. Cricket Association. The same was true of the Canadian Field Hockey Association (President 1969-71).

His honours were many: honorary degrees from Bishop's, Acadia, Memorial, U.B.C.; a Guggenheim Fellowship; a Festschrift of which any Classical scholar might be proud: *Classical Contributions*, New-York, 1981. The Greek Government named him Commander, Order of the Phoenix (1979), the highest Greek honour open to a non-Greek. In 1958 he was elected to The Royal Society of Canada.

Marguerite B. Guinn, his wife for just over 50 years, predeceased him by 10 months. He is survived by a daughter, Heather, a son, Rob Roy, and five grandchildren.

MORLEY G. WHILLANS

Murchie Kilburn McPhail
1907-1989

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

Among those who knew him, MURCHIE McPHAIL had everything: a brilliant scholastic record, a fine scientific career, a beautiful and talented wife [Irene], three successful children, and a most engaging personality.

Murchie McPhail was born in Kilburn, New Brunswick, and grew up in British Columbia. His academic promise appeared early and naturally led to university. Following a first class degree in zoology at The University of British Columbia, he acquired a Ph.D. in biochemistry and physiology at McGill University in 1932. His progress was helped by at least seven awards: scholarships, a bursary, studentships, and finally, a post-doctoral 1851 Overseas Research Scholarship in 1932-34.

Dr. McPhail's first academic appointment was as Assistant Professor of Physiology and Pharmacology at the University of Alberta. He then spent seven years at Dalhousie University in the Chair of Pharmacology. I succeeded Murchie there, and I wonder how much the teaching of pharmacology suffered from the change. His next appointment was with the Vicks Chemical Company in New York, where he remained until the exigencies of the Cold War led to his return to Canada. As head of Physiology in the Suffield Experimental Station in Alberta, he soon emerged as a leader in the understanding of the toxicities of nerve gases. During this very active period, he was elected President of the Canadian Physiological Society, and in 1968 was elected a Fellow of The Royal Society of Canada. He had a warm friendship with Sir Henry Dale, who always made a point of visiting the McPhails while in Canada.

The McPhails returned to Ottawa where Murchie held the Directorship of Biosciences Research in Defence Research Board Headquarters until his retirement.

A short review of Murchie McPhail's work can do only scant justice to its scope and quality. Murchie's solid training, thoroughness, initiative, and conscientious attention to detail led to a wide range of papers, about forty in the open literature on both sides of the Atlantic, and at least eighteen in classified publications. His first study, a pioneering survey of phytoplankton in the Strait of Georgia, was done while still an undergraduate. Later, his work on the hormones of the placenta was followed by a variety of projects in endocrinology, mainly related to progestational and anterior pituitary hormones and the adrenal glands. His papers on the mouse adrenal published in *Anatomical Record* in 1942 are regarded as milestones. Later, he and his colleagues at Suffield became internationally recognized for the consistently high quality of their classified papers on the pharmacology and toxicology of the nerve gases, as administered by inhalation and percutaneously.

Murchie loved and collected books, especially old classics, and he digested their contents with passionate thoroughness. I was caught out when I had misquoted an obscure Latin author in one of my papers. It was only Murchie, among the many who must have read the paper, who detected my error. Characteristically, he told me of it with good-humoured restraint.

Sadly, Murchie's retirement was marred by Alzheimer's Disease. Irene's faithful ministrations enabled him to remain at home. Now that Murchie has

gone, Irene continues to assist such unfortunate cases — a memorial to her husband.

We shall always be short of people like Murchie McPhail, quiet, dedicated, highly intelligent, the soul of integrity, and delightful company. That was Murchie McPhail.

MICHAEL L. KLEIN, F.R.S.C.

James Alexander Morrison
1918 - 1987

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

JAMES ALEXANDER MORRISON was one of those illustrious Canadians, born and raised in the West, who moved to Central Canada to play a vital role in the development and enrichment of Canada's scientific fabric. He served the National Research Council for 23 years, as research scientist, section head and eventually Director of the Division of Chemistry (1966-69). He was Editor of the *Canadian Journal of Chemistry* (1963-69) and Editor-in-Chief of the *Canadian Journals of Research* (1966-69). In 1969, he moved to McMaster University as a Professor of Chemistry and the first Director of McMaster's Institute for Materials Research. He made many contributions to our understanding of the properties of solids at low temperature and the behaviour of absorbed gases, primarily through the use of calorimetric techniques. He will be remembered not only for his achievements as a researcher and educator, but also for his marvellous sense of humour and his generous and unselfish support of young scientists and colleagues.

Jim Morrison was born 11 June 1918 in Medicine Hat, Alberta, and died in Ancaster, Ontario, 20 October 1987. His parents, James Davidson and Charlotte (nee McIntosh), immigrated to Canada in 1908 and 1912, repectively; they were married in Brandon, Manitoba, in 1914. Jim was educated in the local schools and in 1938 entered the University of Alberta to read Chemistry. He received his B.Sc. in 1940 and stayed on to complete a M.Sc. under the guidance of A.E. Boumer. It was common at that time for aspiring young scientists to complete their studies at McGill University. Jim was no exception; he obtained his Ph.D. under the supervision of Bob MacIntosh. During this period Jim boarded at 2063 Stanley Street, as did such future bastions/stalwarts of Canadian Science as Arthur Bourns, Jim Holmes, David McLean and Louis Siminovitch, who were lifelong friends.

After completing his doctorate in 1943, Jim married Irene Jacobson. But it was war-time Montreal; Irene returned to Alberta and Jim stayed on at McGill to carry out research on toxic chemicals for the Department of National Defence, under the supervision of Otto Maass. At the end of the war, Jim returned to more academic pursuits and took up a postdoctoral position with Jack Aston at The Pennsylvania State University. There, Jim learned the low-temperature calorimetric technique that was to launch him on his scientific career. In the fall of 1946, at E.W.R. Steacie's invitation, Jim joined the Division of Chemistry at the NRC in Ottawa, and soon established a world-renowned laboratory for calorimetric studies. He had a knack for performing straightforward, timely, and precise experiments on well-characterized samples. His pioneering low-temperature studies on glasses and elemental substances are still often cited. It was towards the end of his time at NRC that Jim began his extensive series of experiments on the properties of solid methane. These continued at McMaster University, with collaborators in France, Germany and Japan, even after he "retired"and became an Emeritus Professor in 1986. He liked to jest that his interest in this subject had been kindled by the combustion experiments he carried out, as a child in Medicine Hat, on "bubbling puddles of rainwater", a local phenomenon due to emanations of subterranian natural gas. Over the years, more than 50 postdoctoral

fellows and graduate students, from all over the world, were trained in Jim's laboratory, and he published about 150 scientific articles.

Jim and his devoted wife Irene had five children, Jim, Cathy, Peggy, Bob and Susan. Irene and Jim's hospitality was legendary; innumerable distinguished visiting professors, seminar speakers, new faculty, postdoctoral fellows and graduate students were treated as extended family both in Ottawa and in their Ancaster home on Lover's Lane. There were parties every semester to which faculty, staff and particularly graduate students were invited. Informality was the order of the day.

As a director and scientific administrator, Jim lead by example; he worked very long hours and usually returned to the laboratory in the evenings. The sight of an Emeritus Professor in the lab at 23:00, while somewhat daunting to even his younger colleagues, served as a remarkable role model for students. His integrity and selflessness were unmatched; those of us fortunate to have worked under him knew little of the efforts he went to in order to ensure that our scientific lives were idyllic. In this regard, he modeled himself on E.W.R. Steacie. His approach, like Steacie's before him, was to identify gifted and talented young scientists and do the outmost possible to facilitate their research. After Steacie died, Jim was one of the founders of the E.W.R. Steacie Memorial Fund; as Chairman of the Board of Trustees he succeeded in making the Fund's annual Steacie Prize the most prestigeous award available to young Canadian Scientists.

With the vast effort he devoted to research-oriented activities it might be easy to overlook his contributions to undergraduate instruction. However, a walk across the McMaster campus with him left no doubt that he was a very popular teacher, in spite of the fact that he taught Thermodynamics! Much of his "spare" time was devoted to photography, but he also enjoyed music, theater, and travel in Scotland. The latter gave him the opportunity to discover and appreciate rare and unusual malt whiskies.

In recognition of his achievements he received many honours and awards. He was elected a Fellow of The Royal Society of Canada (1955) and the Chemical Institute of Canada (1955). He was awarded the Chemical Institute of Canada Medal (1968), the Montreal Medal (1985), the Speirs Medal of the Faraday Division of the Royal Society of Chemistry (1985), the Huffman Medal of the Calorimetry Conference (1987), and an honorary degree from McMaster University in its Centennial year (1987). The support of his devoted family, his love of science, and the quest to unravel the mysteries of "marsh gas" sustained him in his final illness. The Special (posthumous) Issue of the *Canadian Journal of Chemistry* containing 70 articles from more than 200 contributors serves as a testament to the esteem with which he was held by friends and colleagues around the world.

SAUL WOLFE, F.R.S.C.

Lloyd Alexander Munro
1899-1987

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

LLOYD ALEXANDER MUNRO, Emeritus Professor of Chemistry at Queen's University, was born in Pictou County, Nova Scotia, in January 1899, and died in Brampton, Ontario, in August 1987. With his wife, Della, he had moved to Brampton from Kingston just a few months earlier to be closer to the family of his son Douglas.

Although he was born in Toney Mills, his family migrated to Manitoba when he was quite young, and returned to Pictou County a year later to settle in Stellarton, where he received his early education. After Stellarton schools he attended Pictou Academy, graduating in the class of 1917. He immediately enlisted and went overseas with the Canadian Signal Corps, returning in 1919 to enrol at Dalhousie University, from which he graduated in 1921. After receiving his Master's degree in 1922, he was awarded a series of scholarships by the National Research Council which allowed him to enter a doctoral program at McGill University. He completed this program in 1925, in the laboratory of F.M.G. Johnson, Department of Inorganic Chemistry. At the age of twenty-three he was elected to the Nova Scotian Institute of Science, and his first paper, "A Study of Molybdenum Blue", was read to this Institute on 8 January 1923. This paper already contained the seeds of his subsequent scientific and academic efforts: an interest in the history of chemistry, an enthusiasm for the creation and uses of colours, and a meticulous documentation of the experimental facts. Following the completion of his Ph.D., he joined The University of Manitoba as Assistant Professor of Agricultural Chemistry, and moved to Queen's University in 1929, where he remained for 38 years until his retirement in 1967.

Chemistry had been offered at Queen's, as a part of "Natural Philosophy", from the founding of the institution in 1842. It became a separate subject in 1854 with the establishment of a Faculty of Medicine, and the first Professor was appointed in 1859. Subsequently a Chair of Chemistry and Mineralogy was created in 1882, as part of the School of Mining and Agriculture. Following an announcement in 1886 that a School of Practical Science was to be established in Toronto, a series of public and private efforts led to the formation of a Faculty of Practical Science at Queen's in 1893. From its inception the Faculty offered a four-year program consisting of a common first year followed by specialization in a branch of engineering or natural science. To this day, Queen's maintains two parallel programs in Chemistry, one in Applied Science and one in Arts and Science. Because of the common first year, it was a particular challenge for skilled lecturers to try to inspire the best engineering students to follow in their own disciplines. For many years this responsibility fell to Munro, and led to huge numbers of chemistry and engineering chemistry students in the upper years. He earned the lifelong respect and affection of his students through his mastery of lucid expression, Scottish economy of words, sense of humour, and innate empathy and understanding. Many wrote him with surprise and pleasure following the receipt of book prizes for particular accomplishments in his courses. Towards the end of the 1950s he began to place his ideas on the teaching of chemistry to engineering students on paper and, in 1964, completed his widely acclaimed text

Chemistry in Engineering. Within a short time this text passed through ten printings, was translated into several foreign languages, and was adopted by universities throughout North America, including the hated University of Toronto.

The formal organizational structure of chemistry in Canada dates from 1902, when the first Canadian section of the Society of Chemical Industry was organized in Ontario. In 1919, the first Dominion Convention of Chemists was held in Ottawa. This led, two years later, to the chartering of a Canadian Institute of Chemistry. However, the Institute encountered constant organizational and financial problems because of the continued existence of other, rival, bodies. At the Kingston Convention in 1935, Munro had participated in the organization of a symposium devoted to the problem, but the Chemical Institute of Canada, as we know it today, did not become a single national organization until January 1945. It was quickly recognized that the unification would benefit greatly from the creation of a national journal and news magazine, and this task fell to Munro. Almost single-handedly, he undertook the work of assembling, editing and publishing the *Chemical Institute News* during the critical formative period from June 1944 until June 1946, when he became Chair of the Editorial Board. The journal was renamed *Chemistry in Canada*, at Munro's suggestion, in 1948. He continued to serve until 1964 as, variously, Chair of the Journal Advisory Committee, and Chair and member of the Editorial Board of *Chemistry in Canada*.

At the outbreak of the Second World War he again volunteered to serve his country, and was appointed to the Army Reserve with the rank of Captain. Soon afterwards, he was recruited by Otto Maass for chemical warfare research, which continued until late 1945.

For his contributions to his profession and his country, he was elected to Fellowship in the Canadian Institute of Chemistry in 1937 and to Fellowship in The Royal Society of Canada in 1947, and he received a Centennial Medal from the Government of Canada in 1967.

During his active scientific career, Munro published some three dozen papers on the chemistry of gels, colloids and resins and on chemical catalysis. As consultant to the Hendry-Connell Research Foundation, he carried out investigations into the use of colloids in the detection and treatment of cancer. A seminal 1944 paper in the *Journal of Physical Chemistry* is entitled "Protective Colloids in Cancer". His enthusiasm for colours was manifested in his garden, and his interest in the history of chemistry was expressed through a series of articles and public lectures on the subject of "Chemists and Chemistry on Stamps". At the time of his retirement he was asked to comment on his professional philosophy. His reply was succinct: "...to accept facts and be absolutely honest in interpretation of research". As we approach the twenty-first century, the openness and integrity that once characterized scientific discussion seems increasingly to have been replaced by a rush to publish undocumented and unreproducible claims. It is, therefore, useful to recall the simple credo of a man whose life and work spanned most of the present century.

WILLIAM BLISSETT, F.R.S.C.

Francis Ethelbert Louis Priestley
1905 - 1988

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

It is with regret that The Royal Society of Canada notes the death on 11 May 1988 of FRANCIS ETHELBERT LOUIS PRIESTLEY. Professor Priestley did not like, or use, or even disclose any of his three given names, and so over the decades he was known to colleagues, former students, and friends simply as FELP.

He was born in Banbury, England, on 12 March 1905, and received his primary education in the Northampton Town and Country School. When the family came to Canada, he attended Lethbridge High School and the Calgary Normal School before proceeding to the University of Alberta, from which he graduated in 1930 and received his Master's degree in 1932. While there he debated in the champion team that all but held its own against the dreaded touring Oxonians, an experience that marked him for life. In the rugged times of the Great Depression, FELP taught school in tiny rural schoolhouses, played a mean banjo in jazz combos, became very knowledgeable about minor-league baseball in the West, and mastered the innards of automobiles and other machines. Now married, he came East with his wife, Carmen, in the late 1930s, and completed his doctoral studies in the University of Toronto. His thesis, an edition of William Godwin's *Political Justice*, was defended in 1940. It was published, in three volumes, by the University of Toronto Press in 1946 and is still in print.

In 1940, with a shining new doctorate, he was appointed Assistant Professor of English in The University of British Columbia by G.G. Sedgewick. He stayed there until 1944. On one occasion Sedgewick (who was famous and loved and feared as a great teacher) was not able to give his usual introductory lectures on Chaucer's language and asked FELP to step in, at short notice. Those who sat under him remember his marvellous teaching — clear, brisk, consecutive; and at least one of them still pronounces Middle English with FELP's slight Northampton accent.

In 1944 he was appointed to University College, University of Toronto, by A.S.P. Woodhouse. His specialty was Victorian Poetry, and over the years he published many weighty, much-cited, often-reprinted articles on Tennyson and Browning, and in 1973 *Language and Structure in Tennyson's Poetry*, but he was by no means a prisoner in one field of study. His scientific interests led him to do important work on Sir Isaac Newton, to his appointment to the editorial board of the *Journal of the History of Ideas*, and to his active part in the establishment in 1968 of the Institute for the History and Philosophy of Science and Technology in the School of Graduate Studies, University of Toronto. In the Institute he was active until his retirement, and remained an associate until his life's end. Several times he and Professor Woodhouse collaborated in a famous graduate seminar on "The Origins and Development of Romanticism". His good citizenship in the world of learning is proved by his general editorship from 1962 to 1971 of the *Complete Works of John Stuart Mill*; his survey of the Humanities in Canada, 1964; and his assessment, with Harvey Kerpneck, of English Studies in Canada, 1974. He had many other interests, surprising and even quirky, such as the fiction of John Masefield or

the poetry of Robert Bridges, but none of them ever seemed really out of character.

Strong as was his love of truth — and he was a scholar of notable range, energy and accuracy — almost as strong was his love of debate. FELP never argued for effect or simply to score debaters' points but always to convince his worthy opponent — and anyone else who might be listening. Most of his friends would assert that he never lost an argument, and some might mutter that he never conceded a point, but he always stayed on easy terms with any honest adversary who came limping off the field. We remember the slight movement of moustache when he would say (for example): "Oh, I don't know. Seems to me Tennyson was a bit of a thinker." The jaguar was poised for the pounce. (How appropriate that he drove a Jaguar.) Argument for him was like tennis or rapid chess: he played to keep in trim, not because he thought life unserious.

To such a man honours will come in due course. He was elected a Fellow of The Royal Society of Canada in 1953 and a Fellow of the Royal Society of Literature in 1958; in 1949-50 he had been the first holder of a Nuffield Commonwealth Fellowship in the Humanities. He received honorary doctorates from Mount Allison in 1964, Alberta and Western Ontario in 1973, Acadia in 1987; he was an Honorary Fellow of Huron College and an honorary life-member of the Humanities Association of Canada, the Association of Canadian University Teachers of English, and the Victorian Studies Association of Western Canada; and he received the Queen's Jubilee Medal. In 1987 a Lectureship in his honour was established in the University of Lethbridge, and it was a joy to FELP that he was able to hear Professor John Robson, an old former student, colleague and friend, deliver the first annual lecture and Professor Northrop Frye, the second.

Widowed in 1981, in 1985 he married his old friend and colleague, the astronomer Helen Hogg, F.R.S.C. He is survived by her and by his son, Professor Leonard Priestley of the Department of East Asian Studies, University of Toronto.

DON HARDER

D.J. (Sam) Samborski
1922 - 1989

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

DR. D.J. SAMBORSKI — 'Sam' to his family, 'Sam' to his many friends and colleagues — died at the Victoria Hopital in Winnipeg in June of 1989. He was born in Hampton, Saskatchewan, and after returning from overseas army duty in 1945, he commenced studies at the University of Saskatchewan, graduating with a B.S.A. in 1949 and a M.Sc. in 1951. He then graduated with a Ph.D. from Macdonald College of McGill University in 1955. He began his career at the University of Saskatchewan as a Research Associate and in 1956 he joined the staff at the Agriculture Canada Research Station in Winnipeg as a plant pathologist, contributing 31 years of service with the Research Branch of Agriculture Canada.

Dr. Samborski had a brilliant career as one of the world's leading authorities on the genetics and physiology of cereal rust diseases. An active proponent of a team approach in research, he collaborated with other physiologists, geneticists, breeders, cytologists, and morphologists to work on basic and applied problems in cereal rust pathology. He was highly instrumental in making significant advances in the inheritance, effects, and interactions of genes for resistance in host plants, and inheritance of virulence in the pathogen. His work lead to numerous discoveries and concepts in the biochemistry and histology of rust/host plant interactions. Although he was deeply involved in basic research, he never forgot the beneficiaries of his work — the farmer and the public. He energetically worked on practical problems involving field disease surveys, pathogen epidemiology and screening breeder's lines for leaf rust resistance, resulting in the development of rust resistant wheat cultivars that are now widely grown by prairie farmers.

In addition to his research work, Sam was active in numerous professional organizations and committees: he was a member of the Agriculture Institute of Canada, American Phytopathological Society, Canadian Phytopathological Society, Canadian Society of Plant Physiologists, and the Scientific Research Society of Sigma Xi; he had served on the North American Leaf Rust Workers Committee, Expert Committee on Grain Diseases, and as Associate Editor of the *Canadian Journal of Plant Pathology* and Assistant Editor of *Phytopathology*. His work also led to a number of prestigious awards: Fellow of The Royal Society of Canada, Fellow of the American Phytopathological Society and the Canadian Phytopathological Society, Professional Institute of the Public Service of Canada Gold Medal (shared) for contributions of outstanding importance in pure or applied sciences, Dr. and Mrs. D.L. Bailey Award and Award for Outstanding Research of the Canadian Phytopathological Society, and Distinguished Graduate Award, Faculty of Agriculture, University of Saskatchewan.

Dr. Samborski had a highly developed ability to recognize what was important and to formulate concepts. He was quick to share his insights with colleagues and collaborators, and strongly influenced graduate students, postdoctoral fellows, and visiting scholars from various countries who were attracted to his laboratory. He organized and taught advanced graduate courses at The University of Manitoba, frequently served on graduate student committees and as an external examiner for graduate theses. His international

influence was also felt when he acted as consultant to research programs in Portugal, Brazil, Mexico, the Middle East, Italy and Austria, or as chair of various international symposia and working groups. Although often highly critical and demanding of himself and of others, his criticisms were well placed, done in the context of his humane and congenial disposition. Personal criticisms were never intended and were rarely perceived. His wit, often irreverant humour, and exceptional sense of timing enlivened many otherwise serious scientific meetings. Sam attracted people around himself, and whether working or relaxing there was always both laughter and serious discussion.

Sam spent a great deal of this time with his family, and one of his greatest joys in retirement was to devote time and energy to his grandchildren. He will be sorely missed by his wife Margaret; two daughters, Lynn and husband Kevin Crouch, and Pat and husband Kevin Cutting; his three grandchildren Melanie, Steven and Megan; his four brothers Fred, Ernie, Walter and Clifford and three sisters Mary, Olga and Violet; other relatives and his numerous friends and colleagues.

ALAN C. CAIRNS, F.R.S.C.

Donald Victor Smiley 1921-1990

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

DONALD VICTOR SMILEY was born in the Peace River Block, at Pouce Coupe, British Columbia, in 1921, where his father was a United Church minister. Don, as he was called, taught briefly in a one-room school in Alberta before enlisting in the army. He served with the Royal Canadian Artillery in Europe from 1941-45. He received three degrees from the University of Alberta: B.Ed. (1947), M.Ed. (1948), M.A. in Political Economy (1951); and his doctorate in Political Science from Northwestern University in 1954. He married his wife Gwyneth in 1946 and they raised six children.

He had an itinerant five years after getting his Ph.D. in the midst of the academic hiring doldrums of the fifties. He taught for a year at Queen's University (1954-55); served with External Affairs in Indochina as a Political Officer on the International Truce Commission (1955-56); and was employed with the Department of National Defense (1956-57), and the Government of Saskatchewan (1957-59), before he received his first permanent academic post at The University of British Columbia (1959-70). He subsequently taught at the University of Toronto (1970-76), and York University (1976- retirement 1989). He died in April 1990 in his 70th year.

Once established, he quickly compensated for his delayed entry into academic life. A stream of articles, conference papers, monographs, text books and studies for Royal Commissions testified that he had found his vocation.

Although there was a comparative dimension to his work, especially the federal systems of the United States and Australia, his research rarely strayed from Canadian concerns. He wrote on the party system, Canadian nationalism, public administration, and the strengths and weaknesses of political science as an academic discipline in Canada. However, the subject to which he returned, and where his intellectual influence was greatest, was federalism, and more generally the Canadian constitution.

He influenced several generations of students with three editions of his basic federalism text book, *Canada in Question* (1972, 1976, 1980), and its more essayistic successor, *The Federal Condition in Canada* (1987). He had a remarkable capacity to coin new terms, highlight emerging tendencies in Canadian public life, and address the big issues troubling Canadians. Two of the seminal terms he introduced, "executive federalism" and "intrastate federalism", cast new light on the workings of and tensions in Canadian federalism. By the former, he meant the "relations between elected and appointed officials of the two orders of government in federal-provincial interactions". This underlined for his readers that federalism was not just a legal system whose jurisdictional boundaries were policed by courts, but was also an interdependent political system that was worked and managed by an intergovernmental network of politicians and administrators. By the latter, intrastate federalism, he meant the extent to which the central government incorporated and was sensitive to the provincial dimension of Canadian existence, the "territorial particularisms" as he called them. He argued convincingly that Canadian scholars had paid too much attention to the division of powers between the two orders of government, and too little to the presence

or absence of effective provincial inputs at the centre. Federalism, he argued, was as much about the latter as the former.

In a famous article, "The Structural Problem of Canadian Federalism", *Canadian Public Administration* (Fall 1971), he attributed the Canadian constitutional crisis to the weak and limited expression of provincial interests within the central government. The centre, he claimed, was too majoritarian and pan-Canadian, and insufficiently federalized. This intrastate federalism thesis provided the impetus for one of the basic orientations to constitutional reform in the seventies and eighties, of which Senate reform proposals were classic illustrations.

Don Smiley was not a fan of a competing approach to constitutional reform identified with Prime Minister Trudeau, the Canadian Charter. He used his Presidential address to the Canadian Political Science Association in 1969 to launch a fundamental critique of the Charter enterprise. In essence, he believed that rights were evolutionary, and respect for them always involved judgment and tradeoffs. Accordingly, it was an act of intellectual arrogance to impose a rights straitjacket on future generations who would confront problems and dilemmas that those who drafted absolutist Charters could not predict. Smiley, therefore, was a passionate supporter of what he called the master tradition of parliamentary democracy, that a legislature could do anything but bind future Parliaments.

He was not a narrow scholar. He read widely in the social sciences and had an abiding interest in political philosophy. Indeed, Richard Simeon, an admirer and younger colleague, appropriately described him as an "academic scavenger". His personal library was heavily stocked with literary classics, especially British and Russian novels, and poetry. In his last decade, he gained great pleasure from music, and acquired an impressive collection of records and cassettes.

Nor was he an austere, reserved scholar. He was deeply moral, indeed religious, although he kept the latter to himself. He was a strong supporter of civil liberties. On occasion, he could be a passionate controversialist, although this was more evident in private discussions and in his many letters to the editor, than in his more scholarly publications.

The latter, however, were also driven by passion. Throughout his scholarly career Canada's survival always seemed precarious. His research and publications were directed to giving long life to the country he loved. Longevity required a flexible constitutional order capable of adaptively responding to the tensions derived from French-English duality and also to those that reflected conflicts between central Canada and the peripheries. That these difficult tasks had to be undertaken next door to the American colossus constituted the compounded crisis of Canada's existence, to the resolution of which much of his scholarship was directed.

He was a university man, but not an organization man; he was more at home in the university as a community of scholars than the university as a bureaucracy held together by instrumental allegiance to the same pension fund and parking lots. Although his influence on students and colleagues was

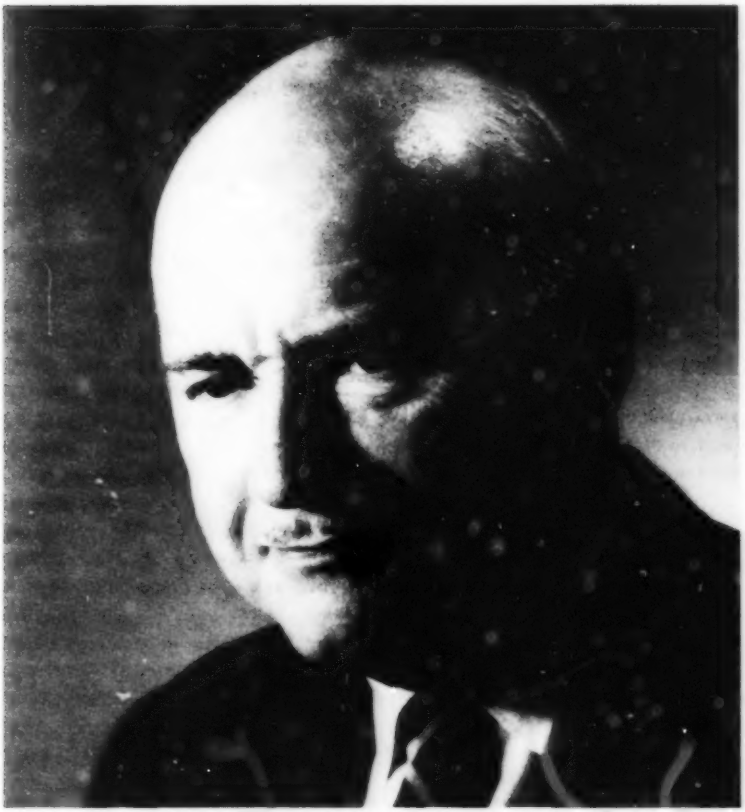
extensive, he did not seek followers, and he would have been repelled by the idea of a Smiley school. An important aspect of his personal philosophy was revealed in his attitude to public parks in big cities. He thought of them as admirable creations, for the rules seemed both few and implicit; individuals could go their own way and do their own thing, and there were almost no collisions. The same commitment to personal autonomy explains his sympathy for the tribute Emily Carr paid to Lawren Harris in her autobiography. "He did not seek to persuade others to climb his ladder. He steadied their own, while they got foot-hold."

He received a goodly share of well-deserved honours — President of the Canadian Political Science Association (1968-69), Fellow of The Royal Society (1974), Distinguished Research Professor at York University (1984), and an honorary degree awarded posthumously by the University of Alberta in 1990. He was also the English language editor of *Canadian Public Administration* from 1974-79. The recognition that meant most to him, however, was the conference honouring him in 1988 at York University, which led to the publication of the *festschrift, Federalism and Political Community: Essays in Honour of Donald Smiley* (1989), ed. by David P. Shugarman and Reg Whitaker. This volume contains an up-to-date bibliography of his writings, his own personal reflections on political science and political power, and an indication of the respect and affection in which he was held by the contributors who thought of themselves not as a Smiley school but as 'Smiley's people'.

He was deeply devoted to his family. He is survived and will be deeply missed by his wife Gwyneth, his son Bret, daughters Carol, Patricia, Judy, Alison, and Rhonda, granddaughter Rachel and his sister Joyce.

J.L. GRANATSTEIN, F.R.S.C.

Charles Perry Stacey
1906 - 1989



TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

CHARLES PERRY STACEY, who died on 17 November 1989, had a most distinguished career as a historian, soldier, teacher, and historical administrator. He unquestionably ranks as one of the most important historians of this century.

Born in Toronto on 30 July 1906, Stacey was educated at the University of Toronto, Corpus Christi College, Oxford, and Princeton University from which he received his A.M. and Ph.D. degrees. By the time he took his doctorate in 1933, he had already had almost a decade of service in the Non-Permanent Active Militia's Corps of Signals and on the Officer Reserve, an early indication of the direction his scholarship would follow. From 1934 to 1940, he taught in the History Department at Princeton and published his first book, *Canada and the British Army* (1936), but he did not leave the neutral United States until a year after Canada's declaration of war. The occasion for his return was his appointment as historical officer at Canadian Military Headquarters in London. The new Chief of the General Staff, an uncommonly intelligent soldier, General H.D.G. Crerar, had read the draft of Stacey's second book, *The Military Problems of Canada* (published in 1940) for the Canadian Institute of International Affairs, its sponsor, and he had been impressed. Crerar was determined that the writing of the army's story in this war would be better handled than was the case for the 1914-18 war, and he had found his man. Major Stacey, as he now became, soon got matters in hand overseas. Like many servicemen, he left his wife of one year, Doris Shiell, behind; it was four years before they saw each other again. As historical officer, Stacey presided over a small staff, collected the records, and wrote narratives on operations soon after they occurred. His historians were attached to combatant units to get the story straight (or as straight as possible) from the participants. For Stacey, this was the living out of every historian's dream: to be on hand in a privileged position to watch great events unfolding.

He more than lived up to the opportunity. Returning to Canada to become the head of the Army Historical Section, his small section produced and, in 1948, published a preliminary history of Canada's war, *The Canadian Army, 1939-1945*, a book that won him the Governor General's Award. The first volume of the full-scale history of the army, *Six Years of War*, appeared in 1955, to be followed by the story of *The Victory Campaign* in Northwest Europe five years later. These were models of official history, fair, critical but not judgmental, and meticulously researched and written. Even if these books were all he had published, Stacey would rank with the best historians this country has had.

Happily there was much more. In 1959, the two hundredth anniversary of Wolfe's victory, he published the finest history of the battle of Quebec, and the next year Stacey retired from the army as a Colonel. For the next seventeen years (except for a year to set up the Directorate of History at the newly unified Canadian Forces Headquarters in Ottawa), he taught at the University of Toronto. In this time, Stacey published his masterpiece, *Arms, Men and Governments: The War Policies of Canada, 1939-1945* (1970), a truly magisterial book that covered the entire sweep of war policy in superb style.

He also wrote his study of Mackenzie King, *A Very Double Life* (1976), a book that created a public sensation with its revelations about King's spiritualism and (regrettably, very limited) sex life. This was followed by a sweeping, opinionated, two-volume history of Canadian foreign policy, *Canada and the Age of Conflict* (1977, 1981), and by a splendid memoir, *A Date With History* (1983), much the best yet written by a Canadian historian. If a scholar's books are the equivalent of battle honours on a regiment's colours (a most appropriate metaphor for a military historian), then Stacey's flag was festooned with honours indeed.

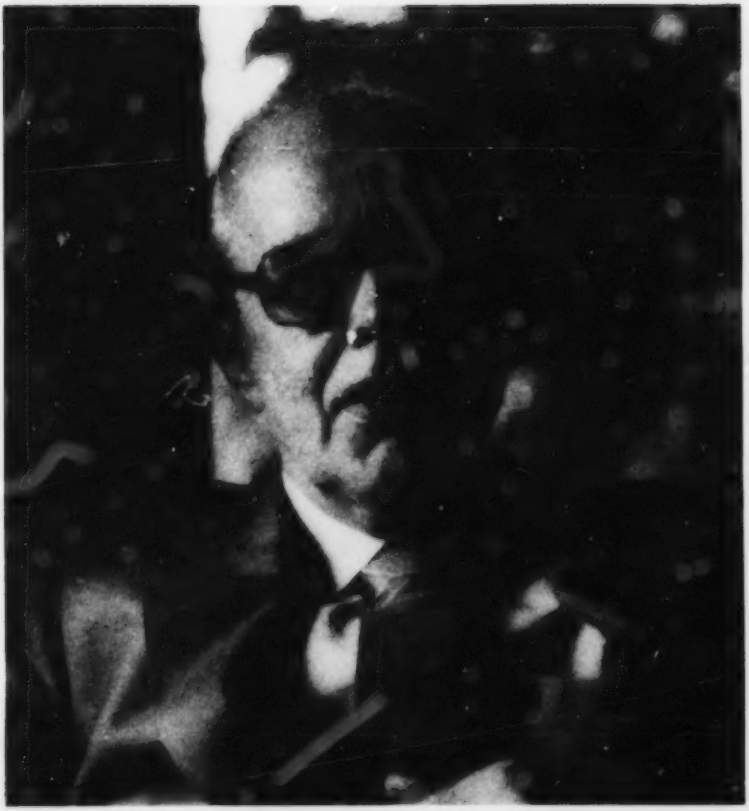
Military history is not ordinarily a specialty much honoured by Canada's historical fraternity, but the Colonel's peers (and his public) recognized his merits. He won The J.B. Tyrrell Historical Medal of The Royal Society of Canada in 1955, served as the Honorary Secretary of the Society from 1957 to 1959, and was President of the Canadian Historical Association (1952-53). In 1969, he became an Officer of the Order of Canada, and the University of Toronto made him University Professor in 1973.

I studied under Stacey at the University of Toronto in 1961-62 and worked for him at the Directorate of History in 1965-66. Aside from his skills as a historian, teacher, and writer, what struck me most about him was his generosity to and friendship with his students and junior colleagues. The Colonel could be formidable (it took a long time for me to summon up the courage to call him Charles), but young historians such as Michael Cross, Robert Bothwell, and Norman Hillmer became close friends, and it was entirely appropriate that when a *festschrift*, *Policy By Other Means*, was published in 1972, the first two named were the editors, while Hillmer prepared the detailed bibliography of the Colonel's works.

Increasingly crippled by arthritis and hampered by deafness, Stacey's mind remained clear and active to the end. His second wife, Helen Allen, whom he married in 1980, provided him with the love, companionship and care he needed to continue working and writing. The night he died he was preparing a book review; undoubtedly, it would have been as tartly witty — and as correct in its judgments — as all his others.

KURT L. LEVY, F.R.S.C.

Erich von Richthofen 1913-1989



TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

ERICH VON RICHTHOFEN passed away on 27 December 1989. Born in Hirschberg, Silesia, on 8 May 1913, he received his advanced academic training in Madrid, Rome and Venice, before studying at the Universities of Hamburg, Berlin and Frankfurt Main. It was the latter institution that conferred on him the Dr. phil. in 1940 and the Dr. habil. three years later.

Von Richthofen began his teaching career at the University of Frankfurt as *Privatdozent* for Romance Philology (in the broad European sense), specializing in the Mediæval period. After five years as *Ausserplanmaessiger Professor* (Associate Professor) at the same institution, von Richthofen decided to leave his native land, choosing the New World as future base for his teaching and research pursuits. A one-term visiting professorship at the University of Chicago in 1954 was followed by full-time appointments at the University of Alberta and Boston College. In 1964 he joined the Department of Italian and Hispanic Studies, University of Toronto, where he remained until his retirement in 1979.

Von Richthofen's widely acclaimed contributions to scholarship span well over four decades and are spelled out in a dozen booklength studies and some seventy articles. While the mediæval epic was undoubtedly his principal area of scholarly commitment, his list of publications shows an astonishingly broad spectrum of topics, with breadth and depth closely allied. His keen interest in French symbolism produced eight articles and a book on Paul Valéry; his broad comparative vision drew him to explore such thought-provoking topics as Valéry's "Mon Faust" ("*tout ce que Goethe a ignoré*"), "Chanson de Roland" and "Poema del Cid", "Dante and Gerhart Hauptmann" (with particular reference to the German poet's oneiric verse), as well as franco- and italo-hispanic literary relations. The problem of "*Wortbeziehungen*" had challenged his scholarly curiosity in the early fifties and had found expression in a twelve-page article assessing the linguistic impact of Romance tongues on the languages of Scandinavia. Hispanic Toponyms north of California (from Oregon to Alaska) came under scrutiny in three painstakingly documented studies published in the sixties and seventies.

Beside the mediæval epic to whose metamorphosis he devoted his final book (*La metamorfosis de la épica medieval*, 1989) and some of whose "*anciens problèmes*" he sought to resolve in an article published shortly before his death, von Richthofen was keenly concerned with general questions of literary criticism. His essay "Límites de la crítica literaria," first published in *Aquila* (1973) and reprinted in the volume *Límites de la crítica literaria y Analectas de filología comparada* (1973), cautions against the pitfalls inherent in critical methods which, when applied with excessive rigidity, tend to encroach upon the validity of acknowledged theoretical postulates. Von Richthofen's verdict contains the implicit warning not to turn to certain aspects of literary criticism unquestioningly as a panacea, but to bear in mind that, after all is said and done, as a discipline it is still very much in its pioneering stage.

Mandatory retirement came to von Richthofen in 1979. "Retirement" surely was a euphemism for the intense scholarly activity that characterized

the final decade in his life. He lectured in France, Italy, Latin America and Spain (besides Canada and the United States): his untiring research resulted in a host of scholarly articles and reviews and in such penetrating book-length studies as *Sincretismo literario* (1981) and the above-cited *La metamorfosis de la épica medieval* (1989), as well as in the fourth edition of his earlier publication *Vier alt-franzoesische Lais: Chievrefueil, Aüstic, Bisclavret, Guingamor* (1981). His articles for the same period range from the genesis of the "Chanson de Roland" and the "Poema del Cid" to a review of epic problems and their partial solutions, published in *Olifant* (1989).

Significantly enough, one year before his untimely death, von Richthofen returned to a theme that had produced his *coup d'essai* and first book, i.e. *Alfonso Martínez de Toledo und sein Arcipreste de Talavera* (1941). The article "Fuenfzig Jahre Arcipreste de Talavera Studies: ein Ueberblick", published in *Zeitschrift fuer Romanische Philologie*, updated the 1941 publication which had been supplemented by two articles published in 1950 and 1956 respectively. (The overview article, I understand, is to provide the concluding chapter in the translation of von Richthofen's first book, which a Spanish scholar is preparing at the moment.)

Von Richthofen was respected as a teacher, admired as a research scholar and dearly beloved as a gentleman and a friend. His adoptive country honoured him by electing him "Fellow of The Royal Society of Canada" and, some years later, by conferring on him the Society's prestigious Chauveau Medal, citing his "distinguished contribution to knowledge in the Humanities other than Canadian literature and Canadian history". Von Richthofen's passing deprives Canada of a leading mediævalist and a scholar of broad humanistic vision: he will be missed the world over by students and colleagues alike. His fatal illness struck while he was travelling with his wife Eleanor in Greece, a land that he loved and to which he felt akin. While in no way lessening our sense of loss, I find it gratifying that his final illness should have come when he was at the height of his intellectual and critical powers and while he was in living contact with a region that had always filled a very special place in his heart. He died as he had lived, "das Land der Griechen mit der Seele suchend (as Goethe would have it) — indeed a life-long quest for Erich von Richthofen, colleague and friend.

His penultimate book, *Sincretismo literario* (1981), brings together seven interpretive studies of mediæval and renaissance texts that seek to "reconcile — on the basis of a common idea — aspects that appear to be opposed to each other". In my view, von Richthofen could not have chosen a more fitting title and one that throws into more striking relief key traits of his personality. He was quintessentially syncretic, dedicated as a scholar and as a man to reconciling, to searching for harmony and to resolving constructively unnecessary polarization that all too often generates more heat than light. His was a credo of truly classic calibre and all of us are in his debt.

G.C. HANNA, F.R.S.C.

Arthur Gowsell Ward
1914-1989

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

ARTHUR GOWSELL WARD was born in Moose Jaw, Saskatchewan in 1914, the second of three sons of Lena and Arthur Sr. In 1919 the family moved to Belleville, Ontario, and then, in 1922, to Peterborough, where they operated a grocery store. Art was an excellent scholar, and finished high school with top marks when he was 16. Considered too young to go to university, he spent an extra year in school studying German and business courses.

He graduated with a B.A. from Queen's University in 1935 and was awarded gold medals for both mathematics and physics. As a graduate student at Queen's, he made accurate measurements of the energies of beta rays and their ranges in aluminum, receiving his M.A. degree in 1936. During this period he played basketball for the university, became an accomplished tennis player, and developed excellent bridge and poker skills.

He won an 1851 exhibition Scholarship and went to the Cavendish Laboratory in 1937, shortly before Rutherford died, where he studied the very weak gamma radiation from ionium (Th-230) and made an accurate measurement of the half life of N-13. He also measured the half lives of RaC′ (Po-214), AcA (Po-215) and ThA (Po-216), using a single Geiger counter and a novel delayed-coincidence technique suitable for half lives in the millisecond range; his values stood for many years.

In April 1940 he joined what later became the Telecommunications Research Establishment (TRE), the major U.K. radar development laboratory. Stationed initially at Dundee, he subsequently moved to Swanage and then to Malvern. He played an important part in the early development of 10 cm airborne radar and the later 3 cm version. Together with two colleagues, he was assigned the basic patent for the centimetre T/R (transmit/receive) switch, which was considered so important that the inventors each received an award of £1,500 after the war.

In December 1944 he returned to Canada as a member of the Montreal Laboratory, the joint Canada-UK-USA nuclear project from which the Chalk River Nuclear Laboratories (CRNL) grew. He was given responsibility for the Van de Graaff accelerator project at Chalk River, and he became active in the development of ion sources. This accelerator, a major nuclear physics research facility in its day, was the progenitor of the present Tandem-Superconducting Cyclotron laboratory. Art also carried out physics measurements on the NRX reactor during its initial start up, and designed and built apparatus for making nuclear data measurements using neutron beams from NRX. He went to the U.K. in 1948, as head of the Harwell Van de Graaff group, where he initiated and directed the experimental program.

In 1951, Art came back to Canada and joined George Laurence's Nuclear Engineering group. He became head of the Reactor Physics Branch in 1954, Assistant Director of the Reactor Research Division in 1961, and Director of the Applied Physics Division in 1968, a post he held until his retirement in December 1974.

During this second period at Chalk River, he supervised a great quantity of research. His own contributions included, at an early stage, design of instrumentation and shielding for the NRU reactor, but he will be chiefly

remembered for his comprehensive research in reactor physics, especially on the prediction and measurement of fissile fuel "burn up", and of the consequent change in reactivity, following prolonged irradiation. This work was a major component of the Canadian contribution to the celebrated United Nations International Conferences on the Peaceful Uses of Atomic Energy which were held in Geneva in 1955, 1958 and 1962. Its enduring importance was recognized by the American Nuclear Society, which, in 1969, elected him a Fellow of the ANS — the third Canadian to be so honoured — and presented him with their 1969 Special Award, for Fuel Burn-up Predictions and Measurements, noting that "for almost twenty years, (he has) carried the prime responsibility for such predictions and measurements in the development of the Canadian nuclear power system. Being based on natural uranium fuel with the burn-up limited by reactivity, the success achieved by the system relied heavily on the knowledge so developed. The information has proved of considerable value to other nuclear power systems." Referring to Art's other work, the ANS drew attention to his having derived and published the first criterion for xenon-induced instability of nuclear reactors.

With his experience in directing large research efforts, his background in radar and physics, Art was a natural choice to be given responsibility for the development work on the Intense Neutron Generator project (1964-1968) which he carried out with great ability. This ambitious project would have used a very high power proton accelerator to produce neutrons by the spallation of heavy nuclei, and would have provided Canada with a neutron source for research purposes more intense than any available anywhere, even today. When the project was terminated, by a decision of the full Cabinet, Art redirected the highly skilled effort that had been built up into a broad-based Accelerator Physics program, which continues to carry out technically exciting and financially rewarding work.

His capacity for outstanding research covering a very wide area was recognized by election to Fellowship in The Royal Society of Canada in 1957, and he received the 1977 W.B. Lewis Medal of the Canadian Nuclear Association, which is awarded "for technical competence and accomplishment in the field of nuclear science and engineering".

Those fortunate enough to have been associated with him during his long research career will always remember his outstanding qualities as a scientist — a clear and incisive mind, a great store of practical wisdom and common sense, and true kindness and consideration for others.

After retirement, Art and his wife Beryl spent the summers in Deep River, Ontario, and winters in Cape Canaveral, Florida, enjoying golf, gardening and bridge. He died in Deep River on 1 August 1989 after a courageous fight with heart disease that had lasted many years. He is survived by his wife and two of their three sons.

DAVID E. SMITH, F.R.S.C.

Norman McQueen Ward
1918 - 1990

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

NORMAN McQUEEN WARD was born in 1918 in Hamilton, Ontario, where he obtained his public and high school education. He received a B.A. in Economics in 1941 from McMaster University and took his graduate degrees (M.A. in Political Economy, 1943, and Ph.D. in Political Science, 1949) at the University of Toronto. His thesis, written under the supervision of R. MacGregor Dawson, was published in 1950 under the title *The Canadian House of Commons: Representation*. That work, completed near the beginning of his academic career, established his authority as a scholar of national political institutions, a pre-eminence he maintained for the next four decades.

After a year (1943-44) as an economic assistant to the Royal Commission on Provincial Development and Rehabilitation in Nova Scotia, he moved to the Department of Economics and Political Science at the University of Saskatchewan where, with the exception of two one-year leaves — Maurice Cody Research Fellow, University of Toronto (1947-48) and Skeleton Clark Fellow, Queen's University (1958-59) — he remained until his retirement in 1985 as Britnell Professor of Political Science. The Department he joined at Saskatoon then comprised such luminaries among Canadian economists as George Britnell, Vernon Fowke, Mabel Timlin and Ken Buckley; Norman Ward was the sole political scientist in the Department at this time. Although the Department grew slowly until the 1960s, his superordinate energy as a scholar and teacher assured the reputation of Political Science at Saskatchewan as a full partner with Economics in the post-war period.

While he had many opportunities to move elsewhere, Norman Ward possessed a strong love for the university and province of Saskatchewan. His journeys east, to the seat of the institutions whose study he mastered, were infrequent, in part because he travelled only by train or car. Yet through a series of important articles in the 1940s and 1950s on representation, bilingualism and procedure in the House of Commons and then, in the next two decades, with his monograph on *The Public Purse* (1962), the edited memoirs of Chubby Power, *A Party Politician* (1966), and several committee and commission reports he co-authored, among them election expenses (1966), government information (1969), and bilingualism and biculturalism in the House of Commons (1970), he established himself as an authoritative interpreter of national politics. In 1963 he took on the task of revising his mentor's *The Government of Canada* (4th edition), an enterprise he repeated with the 5th edition (1970), and which a decade and a half later had so transformed this classic as to warrant a revised title, *Dawson's Government of Canada* (6th edition), with Norman Ward now its author. In this same period, he sat on the electoral boundaries commissions for Saskatchewan (1965, 1973 and 1976), in each instance co-authoring the commission's report.

The politics of his adopted province also won his attention, as evidenced by *Politics in Saskatchewan*, which he co-edited in 1968, articles in *Saskatchewan History*, and long membership on the Saskatchewan Archives Board and chairmanship of the province's Public Administration Foundation.

His scholarship did not cease on retirement in 1985: the long-heralded biography of *Jimmy Gardiner: Relentless Liberal*, which illness had forced

him to put aside in the early 1980s, was published only six weeks after his death, while in the last months of life he began a new project on the institution he most loved — the House of Commons — as he set about compiling the fourth volume in the series of post-Confederation debates.

Norman Ward's literary achievements were not confined to academic scholarship. Indeed, as he frequently observed, the more demanding form of writing was his humorous essays, which were published in three volumes: *Mice and the Beer* (1960), for which he won the Leacock Medal for Humour, *The Fully-Processed Cheese* (1964), and *Her Majesty's Mice* (1977). At one level the essays revealed the funny side of the serious scholar, but at another they were of a piece with the professor; for his humour was as acute in its observations of human nature as it was wry and gentle. A similar perception and understanding informed his scholarly writing, which while reducing politicians to the level of ordinary mortals at the same time enhanced the reader's appreciation of the complexities of life attendant on a career in public office. Few Canadian academics have held a higher regard for the institutions of politics or for those in whose trust these institutions are periodically placed.

Norman Ward's humanity and tolerance radiate through all his writing. They infused the man as well, whether as teacher or colleague, and they explain the lasting influence he exerted over both pupils and friends.

Elected a Fellow of The Royal Society of Canada in 1962, in his lifetime he received many other honours among which were honorary Doctorates of Law conferred on him by McMaster University in 1974 and Queen's University in 1979, and the award of a Canada Council's Killam Research Fellowship in 1974. He was named an Officer of the Order of Canada in 1976.

Norman Ward celebrated the richness of life, revealed through family, profession, community and country. To each he contributed more than full measure.

DONALD G. JANELLE

William Warntz
1922-1988

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

Canada and the international community of scholars lost an inspiring teacher and scientist with the death of WILLIAM WARNTZ, to cancer, in May 1988. An untiring advocate of the systems view of geography, he sought to uncover principles of spatial organization that were common to phenomena in both physical and human geography. He defined geography as a general science of locations, with descriptive geography describing locations, regional geography classifying them, and theoretical geography predicting them. Mathematics was the key to Bill's early contributions; he was a principal contributor to geography's quantitative revolution (c. 1950s).

Bill was born in 1922, in Berwick, Pennsylvania, in a coal mining area near Harrisburg. Education in Liberal Arts at Berwick School (1936-40) prepared him for undergraduate work in Economics. Interrupted by six years in the U.S. Air Force (1943-48), service with the heavy bombardment group in England earned him the Purple Heart, three battle stars, and several other decorations. He completed the B.S. in 1949, the A.M. in 1951 and the Ph.D. in 1955, all three degrees in Economics from the University of Pennsylvania.

From the mid-1950s to 1966, Bill held concurrent appointments at Princeton University, the American Geographical Society in New York, and the University of Pennsylvania. Two of the discipline's most innovative books in that period included *Toward a Geography of Price* (1959) and *Macrogeography and Income Fronts* (1965). They show Bill's ability to make seemingly disparate interdisciplinary connections (meteorology, economics, and geography) and to combine, skilfully, cartography with mathematical constructs. The later book explains and predicts with uncanny accuracy the geographical patterns of U.S. population and wealth through the last decade of this century.

On daily train rides between New York and Princeton, he wrote *Geographers and What They Do* (1964). This remains an inspiring entrée to the discipline. Another accomplishment, *Geography Now and Then* (1964), is a delightful description of the changing geography curricula in American colleges from colonial days to the 1950s.

In 1966 Bill became Professor of Theoretical Geography and Director of the Laboratory for Computer Graphics and Spatial Analysis at Harvard University. Though not disposed to programming computers, his leadership there influenced some of the major developments in computerized cartography. Many of his younger associates and students at Harvard are now major contributors to developments in geographic information systems (GIS). Bill introduced and edited the important *Harvard Papers in Theoretical Geography* (1966-71). He published imaginative work in this series, including lengthy monographs on map projections and on applications of topological theorems and field quantity theory.

Although Bill did not take a position in Canada until 1971, earlier experiences here were instrumental in developing his geographical thinking. In the post library of the U.S. Air Force Newfoundland Base Command in 1946, he found a book by the controversial Princeton astrophysicist, John Q. Stewart (eventually to become Bill's mentor and friend). An exotic chapter in Stewart's *Coast Waves and Weather* (1945) outlined application of Newton's gravita-

tional concept to studying geographical patterns of population. In 1957, he joined Stewart's Social Physics Project at Princeton. Jointly, they pioneered research on the population potential of the United States, and on general concepts of what Warntz described as Macrogeography. The Newfoundland experience was possibly more important to Bill in a personal way — he met and married his wife Minerva (deceased in 1986) in Saint John's.

Another Canadian experience was significant in giving Bill formal identity with geography. Spatial questions were central to his curiosity as a student, but they arose independently of much formal contact with geography. However, interrupting his work on a Master's degree in Economics (a minor in Geography), he participated in McGill University's 1950 summer course at Stanstead, Quebec. Discussions there with Kenneth Hare, Trevor Lloyd, Edward Ullman, Dudley Stamp and others, stimulated questions about the history of geography's academic development.

In 1971, Bill accepted an invitation to Chair the Department of Geography at The University of Western Ontario, a position he held to 1976. During this time he developed the Macrogeography Workshop, devoted to studying the growth of the North American economic system and global patterns in physical geography. These were dominant themes of this work through 1978. Afterwards, the history of geography and its contemporary role in society marked the foci of his research.

Bill received many honours: President of International Regional Science Association (1965-66), Fellow of the American Association for the Advancement of Science, Fellow of the American Geographical Society, Fellow of the Explorers Club of New York City, and Life Associate of Clare Hall, University of Cambridge. However, he took special pride in his affiliation with The Royal Society of Canada. He presented his last published paper on the theme of macrogeography at its Annual Meeting in 1978. "Canada: Its Geographical Unity and Diversity" is interesting reading in the aftermath of the Meech Lake Accord (*Transactions of the Royal Society of Canada*, Series IV, XVI, 1978, 219-49). It is ironic, too, that his first refereed paper in geography dealt with Canadian confederation ("A Methodological Consideration of some Geographic Aspects of the Newfoundland Confederation with Canada, 1949", *The Canadian Geographer*, no. 6, 1955, 39-49).

In his last years, when not teaching and attending to the health needs of his wife, Bill enjoyed exploring the geographical contributions of Isaac Newton and Bernhard Varenius. His last published paper, based largely on archival work at Cambridge University, appearing 10 months after his death, shows a capacity to shed light on contemporary themes in geography through studies of the past. "Newton, the Newtonians, and the *Geographia Generalis Varenii*" (*Annals of the Association of American Geography*, 79, 1989, 165-91) is only a fragment of his intended project. However, it is possibly his most significant contribution to the history of geographic thought.

Bill's unpublished books, research analyses, and correspondence, are in the Warntz Collection of the Regional Science Archives at Cornell University. A book-length manuscript "Distances in the Man-made Environment",

completed in 1971, follows the geometric tradition of spatial analysis. Finished in his final weeks at the hospital, "Place Names, Probabilities, and Priorities", is now in review for publication. The correspondence is particularly revealing about the status of Geography at Harvard in the 1960s and about his intellectual linkages with Stewart. Bill saved a lot of work for publication after retirement. The collection has significant original analyses and partially-completed manuscripts. They address the geographical spread of printing and the origins of universities in Europe, translations from Latin of Varenius, Newton and other scholars of their era, and the contemporary role of universities in North America.

The work of students and associates is further evidence of Bill's influence. A *festschrift* that marks his retirement from The University of Western Ontario gives several examples (W. Coffrey, editor, *Geographical Systems and Systems of Geography: Essays in Honour of William Warntz*, Department of Geography, The University of Western Ontario, 1988).

Though Bill's lasting contributions are in scholarship, friends recall his accomplishments in other areas. A gifted musician, he worked professionally in the Big-band era. He played trombone, trumpet, piano, and recorder. However, it was, he said "the hi-fi that I play best". He was a fierce competitor in squash and tennis, and a walking encyclopedia and devoted fan of baseball. He was also a self-acknowledged addict for geographical puzzles, paradoxes, and algorithms.

Bill read widely in the fields of astronomy, cartography, mathematics, the history of exploration, and the history of education. He combined a sense of history and social structure with insights from mathematics, economics, and meteorology to produce tantalizing research about geographical patterns. The rigour of a specialist and the breadth of a generalist mark William Warntz as one of geography's outstanding personalities in the Twentieth Century.

R.E. BELL, C.C., F.R.S.C., and
E.R. POUNDER, F.R.S.C.

William Heriot Watson
1899 - 1987

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

WILLIAM HERIOT WATSON died on 9 November 1987, in Victoria. He was an extraordinarily versatile scientist-philosopher, having served during his career as the director of an experimental physics laboratory, a department of mathematics, a theoretical physics group, a large department of physics and a major computational centre, finally becoming a senior consultant to an aerospace engineering company. Throughout this career, nevertheless, his own first interest seems to have been the philosophy of physics and the outer fringes of physical theory.

Watson was born in Edinburgh in 1899, attended George Heriot's School, and won a scholarship to Edinburgh University. He studied mathematics and natural philosophy, receiving the M.A. in 1921 and the Ph.D. in 1925. From 1921 to 1928, he was also a lecturer in natural philosophy. In 1928, he won a Carnegie Research Fellowship to Caius College, Cambridge, and started on a second Ph.D. in Ernest Rutherford's Cavendish Laboratory. The degree was awarded in 1931.

Recommended by Rutherford, Watson received an appointment as assistant professor in the Physics Department at McGill University. Now, at last holding a permanent job, he felt free to marry his fiancée of many years, Marjorie Sowler. Their marriage was long and strong; Mrs. Watson predeceased him by only three months. They left two sons, Peter, of Kingston, Ontario, and Kenneth, of Lakewood, Colorado, and five grandchildren.

During 1929-31, Watson had attended the lectures of the Austrian philosopher, Ludwig Wittgenstein (1889-1951), by now a Cambridge professor. Clearly Watson was much influenced by Wittgenstein; he corresponded regularly with him from McGill, and Watson's first book, *On Understanding Physics* (1938), was explicity inspired by him. Wittgenstein's central philosophical thesis was that the problems of philosophy are basically linguistic rather than logical. His writings are dense and not easily read; Watson's book also is difficult for many working scientists to read. The book nevertheless had sufficient scholarly impact to require a later revision and reprinting, *Understanding Physics Today* (1963).

Watson soon had a reputation as a good but stern undergraduate teacher at McGill. His first postgraduate student was D.G. Hurst, who later held high positions at Chalk River and became President of the Atomic Energy Control Board. Hurst's Ph.D. problem was on the transparency of the alkali metals in the ultra-violet; Watson and he were both neophytes in the work. Watson showed great interest in laboratory techniques, and himself did the tricky glass-blowing that was needed. At the same time, he was giving a course in philosophy with Wittgenstein's *Tractatus Logico-Philosophicus* as a text, and working on far-out theories of the electron in the evenings.

During World War II, Watson got started on the work that will remain as his biggest contribution: the development of slotted wave-guide radiators for microwave antennas. H.G. Booket (later Sir Henry) in England had shown that an ordinary metallic antenna, such as a half-wave dipole, can be replaced by a slot cut in an infinite sheet of metal. Properly excited, the slot radiates in a way similar to the dipole from which it is derived. Watson knew Booker, and

he realized that the metal skin of a microwave wave guide could serve as the "infinite" metal sheet. He set out to investigate how slots could be cut in the surface of the wave guide so as to be excited in a controlled way by the electromagnetic energy inside the guide.

He gathered a small working group led by the late E.W. Guptill, with co-workers M. Telford, J.W. Dodds and R.L. Johnston. Sir John Cockroft, who had worked on microwave antennas as well as nuclear matters, encouraged the work, and support came from the National Research Council, which was deeply involved in radar development. The slotted antenna made fairly rapid progress, and was declared operational. It is reputed to have helped clear out the German submarines from the Bay of Biscay during the latter stages of the War. It also led Watson to the second book, *The Physical Principles of Wave Guide Transmission and Antenna Systems* (1947).

Leaving McGill in 1944, Watson went to Saskatoon as head of the Mathematics Department and then went to Chalk River where he became head of the Theoretical Physics Branch at the National Research Council's Atomic Energy Project (later to be named Atomic Energy of Canada Limited). This was about the time when the new NRX reactor was close to commissioning, but it still leaked. Finally, it was a team under Watson's leadership (the theoretician?) which found the leakage. He still found time to serve on the local school board, including one term as Chair.

In 1950, Watson moved to Toronto as head of the Physics Department, where he was to remain for over ten years. One of his early decisions was to persuade C.C. Gotlied to come to help set up the (relatively new) Computing Centre under his guidance. It remains one of the best. Watson firmly believed that the most experienced and best teacher should be used to teach the most elementary classes. This was a relatively new idea; the tendency was to assign the more junior staff to teach the "joe" classes, but not at Toronto. The great Fermi at Chicago was also teaching the elementary class.

His last post was as a senior consulting scientist with Lockheed in California. In 1972, he and his wife moved to Victoria where many of his friends had settled. Sunday dinner at one of the local hotels was a regular event, often with as many as twenty people in attendance. He will be missed by these friends as well as his friends throughout the country.

C.R. STELCK, F.R.S.C.

Robert Thomas Daubigny Wickenden 1901-1989

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

ROBERT THOMAS DAUBIGNY WICKENDEN was born 1 July 1901 at Outremont, Quebec, the second youngest in a family of seven. His father, Robert J. Wickenden, was an artist from England who had studied in Paris for a decade at the turn of the century. His mother, Ada Ahier, was from Jersey. For young Bob, French and English were native tongues. But as Dr. Wickenden wryly remarked long after retirement, "in the thirties, knowing French didn't carry much potential for advancement".

His advancement in the scientific world came from his own abilities. His parents had moved to Bethel, Connecticut, around 1906 for a period and Bob attended Brown University (Ph. B., 1926) with the idea of majoring in English. But a professor of Geology there found a convert to the earth sciences in the young freshman and set him on his lifetime path. His older brothers Alfred, John and Henry were engineers and surveyors and young Bob went with Henry for a summer, became enamoured to the "bush" and "exploration", and went on to Harvard to pursue Geology, as Austin Teaching Fellow from 1926 to 1930.

During this period, dominant American micropaleontologist, Dr. J.A. Cushman, was giving lectures at Harvard on foraminifera and foraminiferal biostratigraphy and became Wickenden's career-long guru. So, Wickenden's Master's degree (A.M. 1929 in Geology) was followed by a Ph.D. Thesis (Harvard 1931) on foraminiferal studies, later published in part in co-authorship with Cushman himself. Wickenden's appointment in 1930 as micropaleontologist to the Geological Survey of Canada opened the challenge of pioneering Canadian foraminiferal studies.

This pioneer of western Canadian micropaleontology, served as an officer of the Geological Survey of Canada for some thirty-six years. In the depression and in the war years following, Survey officers had wide mapping assignments not necessarily directed toward their field of expertise. We find Dr. Wickenden's name associated with foraminifera but also with mapping (Athabasca River, Peace River, Pine River, Foothills of Alberta, southern Plains of Alberta, Saskatchewan and Manitoba, Hudson Bay junction), glacial deposits studies (western plains, Nova Scotia), groundwater studies (southern Plains of Alberta and Saskatchewan), and the overall Mesozoic stratigraphy of Western Canada.

He had been using his fossil foraminifera to unravel Jurassic and Cretaceous correlations of the western Plains and Foothills when the oil discoveries in western Canada moved him west from Ottawa. In 1950, he established a permanent Calgary office for the Geological Survey in the western Canada basin. This office was the forerunner of the Institute of Sedimentary and Petroleum Geology, now located (since 1966) in northwest Calgary. This institution is fitting tribute to him.

He built well, but much earlier (1939) he attained Fellowship of The Royal Society of Canada in recognition of his initiation of the use of foraminifera for identification of the sedimentary layers in western Canada. For oil exploration this became uniquely invaluable for subsurface work before sophisticated

geophysical tools were available. His primary zonations of western rocks are still in use.

Dr. Wickenden was a scientist out of the natural history tradition deeply engrained in the early Geological Survey of Canada. He acted as a collector of birds and mammals for the Natural History Museum in Ottawa and often, as a skilled taxidermist in his own right, prepared the final display specimens for the Museum. He remained an ardent hunter until well into his seventies and a fisherman always.

His easy manner made friends. The ranchers and farmers in the dustbowl of the thirties recognized him as such. He spotted both water and shallow gas wells for them under the Prairie Farm Rehabilitation Act when Wickenden had been seconded to the Dominion Water and Power Bureau from the Survey. His analysis of the Milk River Artesian basin is still valid. R.E. Folinsbee recalls working with Wickenden in those years when they also did the engineering geology on Cypress Lake Dam. They hand-augured for two weeks across the valley and described the cuttings in the evenings. Total cost was well under $50 — but the dam is still standing.

Dr. Wickenden was a gentleman at all times. A slow whimsy of a smile or chuckle showed his appreciation of wit and of events, whether indulging in scientific discussion or watching a chipmunk on a wood-pile. He enjoyed the spectrum of living, golf in the summer, curling in the winter, hunting in the fall, and it is said that he played a mandolin rather well but it was not a bush companion. He enjoyed his years in the Survey and his only work off the continent was at the request of the Indian Government in 1960 when he taught micropaleontology to government geologists of that country.

He was awarded the Sigma Xi key by Harvard in 1945. He was a founding member of the Cushman Foundation for Foraminiferal Research. He maintained membership in the Paleontological Society, in the Canadian Society of Petroleum Geologists (joined when it was still the Alberta Society of Petroleum Geologists), and was a member of the American Association of Petroleum Geologists. Dr. Wickenden was a Fellow of the Geological Society of America. In 1967, Bob was made a member of the Knights of the Round Table in Victoria. In keeping with his long interest in natural history he was a member of the British Columbia Wildlife Federation. He was active in the work of the Unitarian Church and had helped to establish the Unitarian Church of Calgary.

Bob married Lyla Eloise Rogers in 1929. Their one son J. Nicholas (Nick) Wickenden is an associate professor of History at the University of Alberta, Edmonton. Bob and Lyla, from 1966 on, made Victoria, British Columbia, their retirement home. It was here that complications from a stroke proved fatal on 14 March 1989 in his 88th year.

R.G.E. MURRAY, F.R.S.C.

John Charles Wilt
1920-1989

TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA / SERIES VI / VOLUME I / 1990

JOHN CHARLES WILT, a distinguished medical microbiologist and a developer of diagnostic and health services, died in Winnipeg on 16 April 1989. He had served as Professor of Medical Microbiology in the Medical School of the University of Manitoba for 23 years, in the Provincial Department of Health as a Chief of Service and Director of the Cadham Public Health Laboratory for 7 years and, latterly, for two years as Assistant Deputy Minister of Health in the Province of Manitoba. He retired in 1985.

He was born in Moose Jaw, Saskatchewan, in 1920 and was brought up with all the benefits of a farming background. He attended The University of Manitoba (1939-1945) for medical studies and attained his M.D. (1945). After a brief period of service in the R.C.A.M.C. he returned to Winnipeg for graduate training in pathology, bacteriology, and research leading to a M.Sc. (1950) and a specialist certification in bacteriology; eventually he was admitted to Fellowship in the Royal College of Pathologists, London (F.C. Path., 1966), the Royal College of Physicians and Surgeons, Canada (F.R.C.P.(C), 1968), and in the U.S.A., F.A.C.P. in 1956.

In those days, before there were formal training programs in medical microbiology as an unique component of laboratory medicine apart from pathology, Jack Wilt had to travel in successive summers on his own recognizance to laboratories for special experience with renowned teachers: Professor E.G.D. Murray (Bacteriology, McGill University), Professor N. Conant (Mycology, Duke University), and Dr. M. Sigel (Virology, Communicable Diseases Centre Virus Laboratory, Montgomery, Alabama). With evident competence he served as Assistant Pathologist in the Winnipeg General Hospital (1950-53), and as Associate Professor and Acting Head of the Department of Bacteriology and Immunology in the Medical School (1952-56). So it may not have been so remarkable that he was appointed Professsor and Head of the re-named Department of Medical Microbiology and Director of Clinical Microbiology in the Health Sciences Centre of The University of Manitoba in 1956 at the age of 36. The whole range of the discipline was there to develop, which he did with great energy and skill. A public-spirited attention to providing services that were needed as well as responding to emergent medical problems stimulated the support he required for developing his area of the Health Sciences Laboratory and his Department in the Faculty of Medicine. He was a consultant to all the major local hospitals.

There was a severe epidemic of poliomyelitis in progress in Manitoba, particularly Winnipeg, at the time of his appointment. This allowed him to add to clinical microbiology the first virology laboratory in Western Canada; this was a provident development for Winnipeg because his experience and the epidemiological circumstance brought him major responsibility in the Canadian segment of the initial field trials of the Salk polio vaccine. This work cemented his reputation for meticulous and effective planning of work in the field and in the laboratory. Under his perceptive direction the laboratory prospered and he developed broadly based academic and practical laboratories with teaching facilities that brought more renown and appreciation both local and national. He was a welcome contributor to the meetings of the Laboratory

Section of the Canadian Public Health Association and of the Canadian Society of Microbiologists; he maintained a broad range of scientific contacts and became a major force for sensible decision in these societies as well as among provincial and federal public health laboratory directors at the time of development of universal health services; and he was a Member of the Medical Research Council (1964-71).

He became interested in infections occurring in the Canadian Arctic, stimulated by having to identify and study (1949) devasting outbreaks of poliomyelitis in northern communities, and initiated epidemiological studies by collecting and testing blood serum for the presence of specific antibodies that identify recent and past infections. This led later to recognizing, isolating, and determining the spread of an agent of a chlamydial disease from birds to man producing an illness of variable severity but common in the north (due to peculiar bacteria inducing an intracellular infection). The *Chlamydia* have remained a demanding subject of research for Jack Wilt, his colleagues and students to this day. Through this series of experiences he recognized that medicine in Canada was in need of specialists in infectious diseases, a specialty in which he was becoming competent. He was never one to let a need go unanswered for long. Building on a graduate studies program and well-developed diagnostic microbiology, he worked towards a planned integration of academic and clinical microbiology; some years of preparation and the approval of the Royal College of Physicians and Surgeons paved the way for a much respected Fellowship program for Infectious Diseases physicians at The University of Manitoba. These developments also increased the scope of the Department of Medical Microbiology and induced stronger ties with clinical medicine, which will be a lasting legacy. His spirit and dedication to a broad spectrum of medical education and research extended to continuing education of medical practitioners, and these contacts were important to his understanding of practical problems. Also, the Faculty of Medicine appointed him as an Associate Dean from 1967-76 in charge of several areas including research and post-graduate affairs.

In 1976 he entered a different though intellectually connected phase of his life by becoming Director of the Cadham Public Health Laboratory and Chief of the Provincial Laboratory and X-ray Services Division of the Department of Health. He built new laboratories, elaborated diagnostic services and encouraged research towards the improvement of methods. His evident ability to generate good results led to his appointment (1983) as Assistant Deputy Minister of Health with responsibility for community health programs. This was his post until his formal retirement in 1985.

Although he spent much of his life helping others to attain their goals and in perfecting the art of administration by gentle persuasion, he was a dedicated researcher and student of host/parasite interactions, especially in chlamydial diseases, which led to a large number of publications.

His ability and service to science have been recognized by election to Fellowship in The Royal Society of Canada (1977), by election as President of the Canadian Society of Microbiologists (1967), and by awarding of the

Queen's Silver Jubilee Medal (1977). His University named him Professor Emeritus in 1986 following his retirement. His Province honoured him in 1988 as Provost of the Hunt, Manitoba Order of the Buffalo, which is the Province's highest honour. Finally, in February 1989, the facilities he built were named "The J.C. Wilt Medical Microbiology Laboratories".

Retirement did little to dampen his enthusiasm for public service and being helpful with projects and consultations for the Faculty of Medicine, the Department of Health, the University of Nairobi, and the emerging Medical School in Oman. He continued to serve on the Boards of the Winnipeg Plasma Laboratory, the Winnipeg Rh Institute, the Manitoba Medical Services Foundation, and the Thorlakson Foundation.

He was a fine and generous friend, showing an unflagging drive to help talented young colleagues. He was a family man and, with his devoted wife Eunice, he thoroughly enjoyed the development and activities of their two daughters and two sons who survive him. His family and his friends and admirers treasure many and diverse memories of this happy, energetic and influential doer of good works and dedicated medical scientist.

Appendix
Annexe

PUBLICATIONS OF
THE ROYAL SOCIETY OF CANADA
PUBLICATIONS DE
LA SOCIÉTÉ ROYALE DU CANADA

Publications of The Royal Society of Canada
Publications de la Société royale du Canada

Transactions / Mémoires

The *Transactions of The Royal Society of Canada* contains accepted papers given at the Annual General Meeting of the Society plus biographies of deceased Fellows, and appears annually. Fellows receive one copy of the current issue without charge. For current issues the price to non-Fellows is $20.00. Earlier volumes are available for purchase at prices depending on scarcity and condition. Inquiries and orders should be addressed to The Royal Society of Canada, P.O. Box 9734, Ottawa, Ontario, Canada K1G 5J4.

Les *Mémoires de la Société royale du Canada* est une publication annuelle qui contient une sélection d'exposés présentés lors de l'Assemblée générale annuelle de la Société, et les notes biographiques des membres décédés. Elle est distribuée gratuitement aux membres. Le grand public peut acheter les dernières livraisons des *Mémoires* à 20,00 $ l'exemplaire. Il est encore possible de commander certains volumes antérieurs, le prix dépendant de l'état de la publication et du nombre d'exemplaires disponibles. Prière d'adresser toutes demandes de renseignements ou toutes commandes à la Société royale du Canada, C.P. 9734, Ottawa (Ontario) Canada K1G 5J4.

Proceedings / Délibérations

The *Proceedings of The Royal Society of Canada* contains the records of meetings of the Society at its Annual General Meeting, along with major addresses as given during the course of this four-day event. Fellows receive one copy of the current issue without charge. For current issues the price to non-Fellows is $6.75. Some earlier volumes are available for purchase at prices depending on scarcity and condition. Inquiries and orders should be addressed to The Royal Society of Canada, P.O. Box 9734, Ottawa, Ontario, Canada K1G 5J4.

Les *Délibérations de la Société royale du Canada* regroupe les procès-verbaux des réunions de la Société tenues à l'Assemblée générale annuelle, en plus des principales allocutions présentées au cours de cet événement d'une durée de 4 jours. Elle est distribuée gratuitement aux membres. Le grand public peut acheter les dernières livraisons des *Délibérations* à 6,75 $ l'exemplaire. Il est encore possible de commander certains volumes antérieurs, le prix dépendant de l'état de la publication et du nombre d'exemplaires disponibles. Prière d'adresser toutes demandes de renseignements ou toutes commandes à la Société royale du Canada, C.P. 9734, Ottawa (Ontario) Canada K1G 5J4.

Calendar / Annuaire

The *Calendar* is published annually. It contains a complete listing of Fellows, alphabetically and by Academy (discipline or division); Officers of Council, Executive, Society and Academy Committees; in addition to schedules for the coming year and information and guidelines about symposia, donations, publications, prizes and awards, lectureships, and other Society activities. It is free to members. The cost for non-members is $3.75.

L'*Annuaire* est une publication annuelle dans laquelle sont publiées les listes des directeurs du Conseil d'administration et de l'Exécutif de la Société royale du Canada et de chacune des académies. On y trouve également une liste complète des membres par ordre alphabétique et par académie (discipline/division), un calendrier pour l'an prochain et l'information concernant les symposia, les dons, les publications, les prix et les distinctions, et les autres activités de la Société. Cette publication est offerte gratuitement aux membres et est disponible aux non-membres pour la somme de 3,75 $.

Corporate Plan / Plan d'ensemble

This was first published in 1989 and will be updated in 1992. It is free to members; the cost to non-members is $6.00.

Le *Plan d'ensemble* vient d'être publié pour la première fois en 1989 et sera mis à jour en 1992. Offerte gratuitement aux membres, cette publication est disponible aux non-membres pour la somme de 6,00 $.

Booklet / Brochure

The Royal Society of Canada: Profile of the National Academy is a summary statement on the Society and its activities and is available, without charge, from the Secretariat.

La Société royale du Canada : Profil de l'Académie nationale, l'exposé sommaire de la Société et ses activités, est disponible gratuitement au Secrétariat.

Présentation

Cette publication réunit les discours de présentations des nouveaux membres de l'Académie I par leurs parrains et leurs réponses qui traitent de leur œuvre ou d'un sujet de leur choix.

Tous les numéros de cette publication annuelle, du premier en 1943-44 jusqu'à date sont disponibles. Les numéros 39 à 43 coûtent 6,00 $ l'exemplaire. La série complète coûte 80,00 $.

Index 1882-1982

The *Index* consists of author and subject entries for all papers published in the *Transactions* and other publications of the Society. Available for $30.

L'*Index* auteurs-matières renvoie ainsi à toutes les communications des *Mémoires* et d'autres publications de la Société. Prix: 30,00 $.

Studia Varia

Most volumes are now out of print. Those volumes that are available through The Royal Society of Canada are listed below. All others continue to be available through the on-demand publishing program of University Microfilms, Ann Arbor, Michigan, U.S.A.

La plupart de ces volumes sont épuisés sauf les titres indiques ci-dessous qui sont disponibles au Secrétariat de la Société. On peut se procurer les autres volumes en s'adressant à University Microfilms, Ann Arbor, Michigan, É-U.

Canadian Population and Northern Colonization, V.W. Bladen, ed., 1962, pp. 168, $4.50

Water Resources of Canada/Ressources hydrauliques, C.E. Dolman, ed., 1967, pp. 249, $8.50

Visages de la civilisation au Canada français, L. Lamontagne, éd., 1970, pp. 130, SBN 8020-1659-6, 7,50 $

Le Canada français d'aujourd'hui, L. Lamontagne, éd., 1970, pp. 161, SBN 8020-1658-8, 7,50 $

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Available from Environment Canada/ S'adresser à Environnement Canada.

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Global Change: The Canadian Opportunity/Transformation du Globe: le défi canadien, Canadian Global Change Program Report No. 1, Wm S. Fyfe, ed., 1986. ISSN 1183-0808

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